

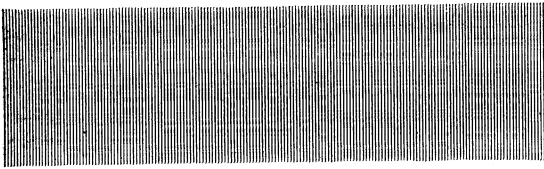
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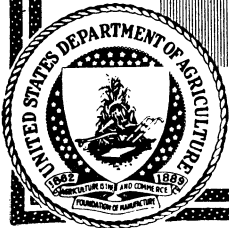
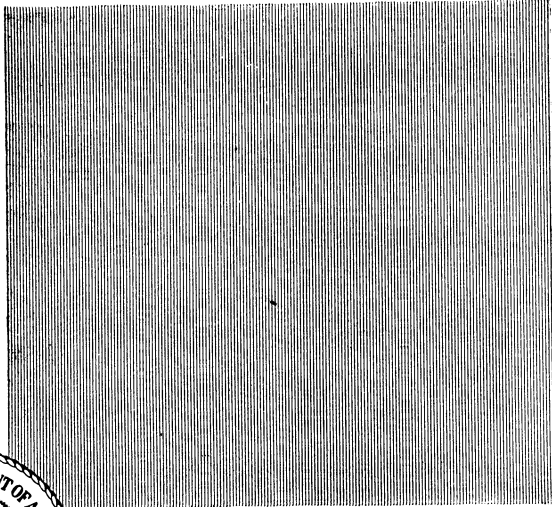
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U. S. DEPARTMENT OF AGRICULTURE

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FARM AND HOME DRYING OF FRUITS AND VEGETABLES



THERE ARE TWO general methods of preserving fruits and vegetables, canning and drying, each of which has certain advantages and disadvantages that should be understood and taken into consideration in choosing a method of preservation. For a number of food materials canning is the preferable method and should be employed wherever possible. For a considerable variety of products drying yields perfectly satisfactory results. For food materials to which the process is adapted, drying offers a simple, convenient, and economical method of preservation and permits of the carrying over of the surplus into periods in which fresh fruits and vegetables are expensive or unobtainable.

Success in drying depends upon the observance of a few fundamental principles, and the quality of the product depends upon the care used in the selection of the raw material, upon proper preparation for drying, and upon careful control of the temperatures employed, rather than upon the particular type of evaporating apparatus employed.

In districts that normally have a rainless period coinciding with the ripening period for fruits and berries these crops may be successfully dried in the sun or by means of glass-covered solar driers. In regions that do not have such favorable climatic conditions, driers employing artificial heat must be used.

A number of driers are described and directions for their construction given in this bulletin. The smaller sizes are adapted to the needs of the individual home and are designed to care for the surplus of garden products and fruits from the home grounds. The larger types are suited to the needs of individuals or communities having a considerable surplus of perishable crops. Wherever possible, the members of a community should cooperate in constructing one of these larger types. All the driers described have been thoroughly tested in practice and are such as may be constructed at very moderate expense from materials everywhere available by anyone who can use ordinary tools.

Directions for the preparation, drying, and subsequent storage and care of the dried products are given fully for each of the more important fruits and vegetables.

FARM AND HOME DRYING OF FRUITS AND VEGETABLES

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POSSIBILITIES AND LIMITATIONS OF DRYING

IN UNDERTAKING the preservation of perishable foodstuffs, choice must be made between two general methods, canning and drying. Canning essentially consists in heating the food to a degree sufficient to destroy the organisms producing fermentation and spoilage already present in the food and in protecting it from new contamination by sealing. Drying consists in removing so much moisture from the material that spoilage organisms, even though present in the living condition, are not able to grow and multiply in it, and in subsequently maintaining it in that condition. Whether dried or canned, the product is so altered that it differs considerably from the fresh material in appearance and flavor. Each method has certain advantages and also certain disadvantages and limitations which require consideration in making a wise choice of the method to be employed for any particular product.

Canning has the disadvantages that it is laborious, that the work must all be done at the time the fresh material is available, that it requires some special equipment, and that the cost of the containers in some cases is prohibitive. It has the further disadvantages that most products are bulky, and hence require considerable storage space, and that considerable deterioration in quality may occur if proper storage conditions are not maintained. Canning has the very great advantage that the processes have been the subject of intensive and prolonged scientific investigation, with the result that

satisfactory methods have been developed for canning practically every fruit and vegetable grown in the Temperate Zone and for canning meats and fish as well. Other advantages, important from the consumer's viewpoint, are that the canned product is practically ready to serve and that in most cases it fairly closely approximates the freshly-cooked material in appearance and flavor, and consequently people do not have to "learn to like" canned products.

Drying, evaporation, or dehydration, as the process is variously termed, has the very great advantages that the product has a weight only one fourth to one ninth that of the fresh material, that there is generally a considerable reduction in bulk, and that some dried materials can be stored for long periods without the use of hermetically sealed special containers. It also has the advantage that some materials can be successfully dried with very little special equipment and consequently at a cost considerably less than that of canning. However, it has very definite limitations and is by no means applicable to all fruits and vegetables. Satisfactory methods for drying a limited number of products, chiefly fruits, have been developed, but no drying methods have been worked out in detail for each of the various fruits and vegetables as in the case of canning. There are some fruits and a considerable number of vegetables that it is not advisable to attempt to dry, either because drying decreases their palatability or because they deteriorate rapidly after drying. Also, there are a considerable number of vegetables that are so readily kept for long periods in storage, either in outdoor pits or in an ordinary cellar, that labor expended in drying them under ordinary conditions would be wasted.

Another point to be considered in making a choice between drying and canning is that canned and dried products differ considerably from each other in appearance and flavor when ready to serve, and consumers often have to learn to accept the dried product. Also, many cooks do not know how to prepare and serve dried materials so as to secure best results. Consumers generally prefer the canned product, as is clearly shown by the enormous development of commercial and home canning during a period in which commercial drying has been confined to a few staple products, with little extension to new materials.

FUNDAMENTAL PRINCIPLES OF DRYING

The preservation of food materials by drying is not a particularly difficult or complex process, but it has certain fundamental principles that must be clearly understood if the work is to be successfully carried out. The purpose is not merely the removal of sufficient moisture to insure the product against spoilage. This must be done in such a way as to preserve the food value and as much as possible of the natural flavor and cooking quality characteristic of the raw material. To do this the work must be carried out in accordance with detailed instructions based on a few simple fundamental principles, which will now be stated.

Wet material exposed freely to the air will ultimately become dry, since the liquid water covering its surface will be converted into water vapor and taken up by the air. The rate of drying will de-

pend upon the temperature of the air and the percentage of moisture already in it. If the air remains at constant temperature and is undisturbed by currents, the loss of water from the material will go on very slowly, as the air nearest the wet surface will soon become almost saturated and can take up more water vapor only as that already held is lost by diffusion outward and upward into drier air. If the air is kept constantly in motion, however, the drying will be greatly hastened, as the air current will displace the blanket of moist air surrounding the material as rapidly as it is formed and bring in drier air to replace it. If the temperature and moisture content of the air are both constant, the rate of drying will increase proportionally as the rate of movement of the air is increased, until a point is reached at which water cannot pass from the interior to the surface of the material as rapidly as the air is able to take it up. The surface will then become dry even though the interior is still nearly saturated. The effect of a brisk breeze in hastening the drying of the surfaces of muddy fields after a rain is a familiar illustration of this principle.

Drying is also hastened by raising the temperature of the air. The amount of water vapor that a given volume of air can absorb depends upon the temperature and is practically doubled by every increase of 27° . If air is warmed from 60° to 87° F., its moisture-carrying capacity is doubled; if the heating is continued to 114° , the moisture-carrying capacity is again doubled, becoming four times what it was at 60° . Further heating produces further increases in the same proportion, until a point is reached at which water is vaporized at the surface more rapidly than it is replaced from within.

There are, therefore, two ways in which the rate of drying can be increased—namely, by increasing the temperature of the air or by quickening its rate of movement. Economical drying is secured by combining the two and forcing currents of heated air over the material at such temperature and rate of movement as will remove moisture from the surface as rapidly as it can move outward from the interior of the material. When this point has been reached any further expenditure of heat or driving force is, of course, wasted.

Generally speaking, flavor and cooking quality are best preserved by rapid drying. When the flesh of fruits and vegetables is opened up to the air, as in peeling and slicing, a number of chemical changes in the tissues immediately begin. If the material is to retain its natural appearance, color, and flavor, these changes must be checked. Some of them produce darkening and discoloration; others break down the pigments, causing the fading of the characteristic colors of the material; and still others affect the flavoring substances, bringing about a decrease or loss of the constituents that give the fruit or vegetable its characteristic flavor. Other accompanying but slower changes result in the partial destruction of the sugars and proteins, sometimes accompanied by the production of new and undesirable flavors and odors. While these changes are in part spontaneous, many bacteria, yeasts, and molds, which are universally present in the air and upon foodstuffs, and which produce similar but much more rapid decomposition, are certain to begin growth in

the material as soon as the removal of the protecting peel gives them access to its interior. Consequently, processes of decomposition begin as soon as the fruit or vegetable is opened to the air and will continue until the greater part of the moisture present is removed unless special means are employed to arrest them. This decomposition would be immediately stopped by raising the temperature of the material to 175° or 185° F., but it is not possible to do this without causing injury. The rapid heating to this temperature in dry air of freshly cut slices of a succulent fruit or vegetable causes bursting of the cell membranes by expansion of their contents and permits the escape of water, which carries with it dissolved sugars, salts, and flavoring substances, thus reducing both palatability and food value. To arrest these changes and to preserve the natural colors and flavors of the material, it is necessary to resort either to partial cooking or to sulphuring. (See pp. 6, 7, 29.)

It follows that rapid drying cannot be secured by the employment of high temperatures with fresh water-filled material without serious injury to the quality and food value of the product. Nor can material already partly dry be subjected to high temperatures, as scorching and charring will occur. The best temperature for drying is therefore the highest that can be employed without danger of injury in either of these ways. This temperature is determined in the case of any particular fruit or vegetable by its physical structure, chemical composition, and water content. As fruits and vegetables show wide variations in these respects, there is no single best temperature for general use; heat treatment that would be perfectly safe with potatoes or carrots would be utterly ruinous to raspberries and peaches. For this reason it has been necessary to determine experimentally for each of the different materials the range of temperatures that may be employed without injury. These are given on subsequent pages. A dependable, accurate thermometer should be placed in the drier and kept under frequent observation, as any attempt to trust to inexperienced judgment as to temperatures in the drier is likely to result in damage to the material.

In drying food material it is indispensable that provision be made for the prompt removal of moisture from the apparatus by a constant inflow of air. The reason is obvious; if the material is placed in a closed box and heated, the confined air will very quickly become saturated and no more water can escape from the material. If the heating is continued, the material will literally be cooked in its own juices. Therefore, a drier can be efficient only in the degree that its construction provides for constant removal of the moisture given off by its contents.

Success in drying, therefore, depends upon the use of suitable means for stopping the series of changes that begin as soon as the material is cut into pieces and exposed to the air, the employment of a temperature sufficiently high to prevent the growth of organisms—yet not so high as to cause the bursting of cells and loss of juices in fresh material or the scorching of that which has lost most of its water—and the provision of an adequate circulation of air for the prompt removal of the water vapor given off. Simple as these principles are, they have been discussed at length because most failures or poor results are due to the neglect of one or more of them.

METHODS AND EQUIPMENT FOR DRYING

CHOICE OF A METHOD

Wherever climatic conditions permit, sun-drying is the least expensive method of preserving foodstuffs. Successful sun-drying demands that a rainless season of bright sunshine and high temperature coincide with the period at which the crops to be dried are maturing, and the extent to which sun-drying can be carried on in any district is determined by the length of its rainless midsummer and autumn period. Ideal conditions for sun-drying all fruits, both early and late, are found in the interior districts of California, where sun-drying has become an industry of large proportions, and throughout the Southwest. In the intermountain region of the Northwest, over the larger part of the Great Plains, and in all but the coastal portions of the South, the sun-drying of such early-maturing fruits as berries, cherries, apricots, and peaches is possible. In much of this territory warm rainless weather usually continues sufficiently far into the autumn to permit sun-drying of such late-maturing fruits as apples, pears, and plums, as well as of such vegetables as sweet corn, pumpkins, and squash. Outside these areas and in any region in which the late summer and early autumn are characterized by frequent rainfall or periods of low temperature and high humidity it will not be wise to depend wholly upon sun-drying, as a few days of rainy weather may cause the loss of a large quantity of valuable material.

The use of artificial heat in drying has the advantage that the work is made independent of weather conditions and it is possible to dry late-maturing crops, such as winter varieties of apples, after cool weather has set in. It has the disadvantages that it requires rather close supervision to avoid overheating and subsequent injury to the material, and it must be a continuous process to prevent the growth of organisms. It has the advantage that if the work is properly done, most products retain their natural appearance and flavor to a greater degree than when sun-dried. The process is more expensive than sun-drying, since an evaporator and a supply of fuel must be provided. For anyone who can use ordinary tools, the investment in a drier may be largely one of time and labor rather than of money, if one of the evaporators described in pages 14-29 is constructed. These evaporators are purposely so designed that they may be built in any desired size to meet the needs of the individual family, a cooperating group, or an individual grower with considerable quantities of material to be handled.

EQUIPMENT FOR PREPARATION OF MATERIAL

The equipment needed for the preparation of the material for drying depends upon the quantity and character of the various products to be dried, and to some extent upon the conditions under which the work is done. Where the work is limited to caring for the surplus from a small home garden or a few fruit trees and not more than a few bushels of any one product is to be dried, the purchase of several machines is neither desirable nor necessary, as the ordinary kitchen equipment will contain everything absolutely necessary. Stainless steel knives, some with short, rather narrow, stiff blades for use in

paring and trimming, others with longer, more flexible blades for slicing, are usually on hand, as are aluminum or enamelware pails and pans. If pears or clingstone peaches are to be dried, coring or pitting "spoons" (really knives having short double-edged blades so curved as to cut closely around the peach stone) should be provided. The vessels used should be such as are not readily attacked by the juices of acid fruits, and the prepared material should not be allowed to come in contact with iron.

Where considerable quantities of material are to be handled, as would be the case in a community drying plant or with an individual operating on a small commercial scale, the purchase of several special machines will be justified by the great saving of time and labor that they will make possible.

If considerable quantities of apples are to be handled, paring machines of a variety of types ranging in cost from \$2 upward are available. The small, low-priced machines are not strong enough to

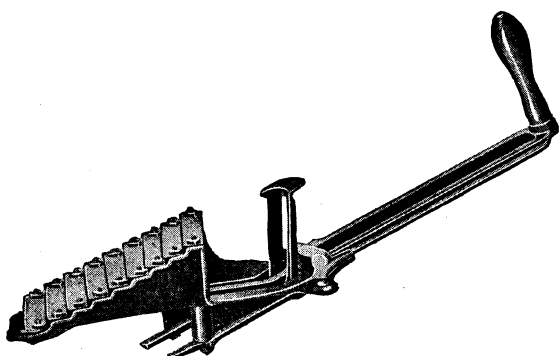


FIGURE 1.—A simple and durable apple slicer which can be used equally well in slicing any of the smaller vegetables.

stand up under continuous heavy usage, but will serve the needs of the ordinary household for several seasons. All of these pare and core the fruit at one operation. Some also have a slicing attachment which follows the paring knife and cuts the peeled fruit into a long spiral. Most operators prefer to remove this attachment and to go over the

pared and cored fruit with a knife to remove seed cells, blemishes, and bits of skin prior to slicing. For use with the evaporator handling apples on a commercial scale, there are several types of substantial, well-built hand-power paring machines having a capacity of 4 to 6 bushels an hour. With occasional replacement of the paring knife, coring spoon, and other wearing parts, these machines will give satisfactory service for many seasons.

For slicing apples after they have been pared, cored, and trimmed, a slicing machine of the type shown in figure 1 is desirable. These machines cut the fruit into slices of uniform thickness at right angles to the core opening at a rate limited only by the dexterity of the operator and ranging from 3 to 6 bushels an hour. Such a machine is equally useful for slicing potatoes, carrots, beets, turnips, and onions. There are also a number of rotary slicers of varying sizes and prices, all of the general type shown in figure 2. These will slice a great variety of products and may be adjusted to cut uniform slices of any desired thickness, but are somewhat less satisfactory for slicing apples than the device shown in figure 1.

If apples, pears, peaches, or apricots are to be dried and it is desired to prevent discoloration and the accompanying changes during

the drying process by exposing the fruit to the fumes of burning sulphur, some form of sulphuring box or chamber is a necessity. (See p. 29.) This must be located outdoors and in such position that the fumes do not become a source of annoyance. If only small quantities of material are to be sulphured, the sulphuring chamber may be simply a tight packing box or a wooden frame, closely covered with roofing paper or wall board, of sufficient size to enclose a stack of trays, with about a foot of extra length. Two blocks of wood are laid on the ground to form a support, raising the lower tray several inches above the ground, and the trays, loaded with the prepared fruit, are stacked one upon another on this foundation, pieces of light lath being placed between them to facilitate the access of the fumes to all parts of the stack. The proper quantity of sulphur is placed in a heavy metal vessel such as an iron saucepan, ignited, placed in the open interval at the end of the stack, and the box is inverted

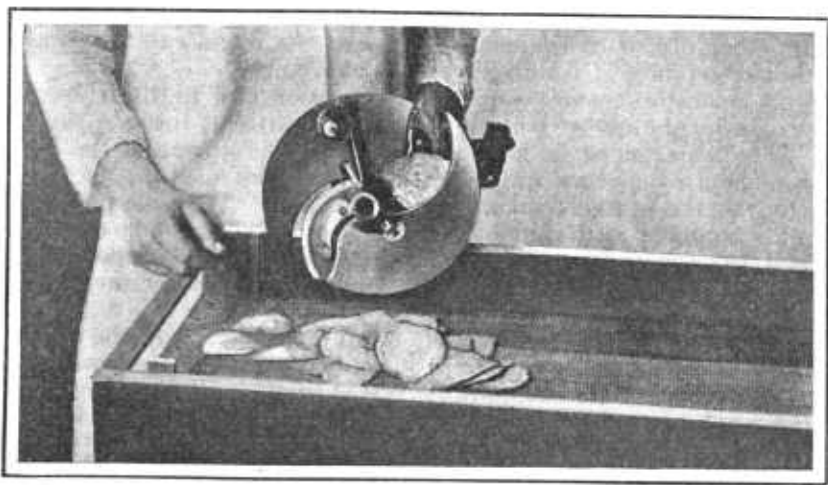


FIGURE 2.—A rotary slicer which may be adjusted to cut slices of any desired thickness.

over the whole in such a way as to fit snugly against the ground and is allowed to remain for the requisite time. When larger quantities of fruit are to be handled, a sulphuring chamber large enough to receive 12 to 20 trays at a time should be constructed. It should be provided with cleats fastened to the sides at intervals of about 3 inches to support the trays and permit free access of the fumes, and there should be sufficient open space below the lower tray for a suitable vessel for the burning sulphur. As the efficiency of the sulphuring process depends upon preventing the escape of the fumes and securing their absorption by the fruit, the door of the chamber should fit tightly, and all cracks should be battened to make the chamber as nearly gas-tight as possible.

If prunes or plums are to be dried, equipment must be provided for dipping them in a hot lye solution, to crack or "check" the skin and thus facilitate drying. A prune-dipping outfit consists of a vessel, preferably enamel-lined, of suitable size to contain the lye solution, some means of keeping this vessel at boiling temperature,

a basket or old bucket with the sides punched full of holes, to serve as a dipping vessel, and an abundant supply of running water, or, lacking running water, two or three tubs of clean, cold water, in which the prunes are rinsed free of lye after being dipped. The kettle is filled with a lye solution made by adding 1 pound of commercial concentrated lye to 10 gallons of water. This is heated to boiling. The fruit is placed in the dipping vessel and plunged into the solution for 30 to 45 seconds, then withdrawn and immediately transferred to one of the vessels of cold water, where the basket is moved about in the water for a minute or two to wash off the lye. The basket is then transferred to a second and third vessel to complete the removal of the lye. The essentials of successful lye-dipping are (1) to keep the lye solution actually boiling when in use, as good checking of the skin will not occur if the lye is not at boiling temperature, and (2) to give the fruit a thorough washing after it has been dipped to remove the lye that would otherwise be absorbed. Such removal requires thorough washing, not a mere perfunctory dip, with frequent changes of the wash water, or washing under a faucet if running water is available.

Some operators secure very satisfactory results in the checking of prunes by the use of boiling water alone without the addition of lye. The water must be kept at boiling temperature and the fruit must be kept submerged in it until minute cracks resulting from the swelling of the heated fruit appear in the skin. The time necessary for this to occur will range between 30 and 120 seconds and will depend upon variety, stage of maturity, and possibly upon other factors, and hence must be determined by experiment for each lot of fruit.

If peaches are to be dried and it is preferred that they be peeled, the same equipment as used for prunes may be used. Most varieties of peaches cannot be successfully peeled with boiling water until they have become too thoroughly soft ripe for drying. Also the use of either boiling water or boiling lye cooks a layer on the surface of the fruit, which subsequently discolors badly. This effect can be entirely avoided by using a 10 percent lye solution, made by adding 1 pound of commercial concentrated lye to each 5 quarts of water and heating the solution to a temperature of 135° to 140° F. Submerge the fruit in the solution for 1 to 2 minutes, rotating the dipping vessel in the meantime to assist in rubbing off the loosened skins. When most of the fruit has been peeled, transfer the dipping basket to a large vessel of cold water or place it beneath a faucet and continue rotation to assist in removing adhering peels, finally completing the process by rubbing the fruit between the hands and rinsing.

Such vegetables as it is advisable to attempt to preserve by drying require partial cooking before they are dried; consequently, if sweet corn, pumpkin, squash, sweetpotatoes, or other vegetables are to be dried it will be necessary to provide some means for giving this pre-cooking treatment. The desired effect can be obtained by placing the material in boiling water, but this results in a considerable loss of food value through solution in the water, as well as the taking up of water which must be driven off before the drying process proper can begin. For these reasons the precooking should be done in steam rather than in water. A steam cooker or a pressure canner, if avail-

able, is ideal for the purpose. A small quantity of water is placed in the vessel and heated to boiling; the prepared material is placed in a wire basket, which is set into the cooker; the cover is set on to retain the steam, and the water is kept at a vigorous boil for the prescribed time. In the absence of a pressure cooker an ordinary wash boiler with a tight cover can be made to serve the purpose if it is fitted with a wire basket to contain the material and a support is provided to hold the basket above the level of the water. Where a source of steam is available, a steam box may be constructed. This may be merely a rather tight wooden box of convenient height and the proper width and depth to receive the trays used, provided with cleats on the sides to serve as supports for the trays and with a tightly fitted door. Live steam is led into the box from the boiler by a pipe or steam line fitted with a cut-off valve. Trays are loaded with the material as rapidly as it is prepared, placed in the box, the steam turned on for the prescribed period, and the trays immediately transferred to the drier. In every case material should be given the precooking treatment as quickly as possible after preparation, in order to prevent the undesirable changes that set in as soon as the material is opened up to the air. (See p. 3.)



FIGURE 3.—A potato peeler that may be used for paring any of the root vegetables.

Vegetable peelers of the general type shown in figure 3 effect a great saving of time and labor where the amount of work to be done justifies the purchase. Such a machine will successfully pare potatoes, sweetpotatoes, parsnips, carrots, turnips, or beets, leaving only a relatively small amount of work to be done by a trimmer, and will quickly pay for itself if large quantities of these vegetables are to be dried. The machine is very simple; it consists of a large cylindrical chamber having a carborundum or perforated steel lining against which the contained vegetables are thrown by centrifugal force when the crank is rapidly turned. The peels are thus scraped

or ground off and carried out of the peeler by a stream of water supplied from a reservoir or water connection at the top of the machine.

DRYING WITHOUT ARTIFICIAL HEAT

DRYING IN THE OPEN AIR

It has already been pointed out (p. 5) that sun-drying should be attempted only in districts that normally have practically rainless weather, with a high percentage of sunshine, high temperatures, and low humidity, during the period in which the drying is to be done. The occurrence of occasional showers alternating with periods of clear hot sunshine is not serious, provided the drying fruit is protected from wetting; but a period of several days of continuously cloudy, showery weather with high humidity may cause the loss of any materials that are only partially dry when it sets in. In districts in which such sunless humid periods frequently occur during the drying season, the wise course is to provide an evaporator of sufficient capacity to take care of these materials during such rainy periods, and to use it only when forced to do so.

The only equipment needed for sun-drying in addition to that already listed for preparing the material is a supply of suitable trays to contain the material. If the quantities to be dried are very small it may be possible to do the work without making special trays for the purpose, by utilizing canvas, heavy wrapping paper, or muslin held in place by strips of lath. The sloping roof of a woodshed or porch having a southern exposure will serve admirably as a place for drying such small lots of material. For handling any considerable quantities, trays will be necessary. If the family has an evaporator for use in an emergency the dimensions of the sun-drying trays should be such that they can be placed directly in the evaporator if necessary. In any case, they should be of uniform size for convenience in stacking and should not be so large that, when loaded with fruit, one person cannot easily handle them. Convenient sizes are 2 by 2 or 3 by 3 feet. The lumber used should be as light as is consistent with durability. The frame of the tray may be made of 1- by 1-inch or 1- by 2-inch strips placed on edge, and the bottom may be made of half-inch boards planed on the upper surface and placed closely together so as to leave only narrow cracks. Some of the more recently developed types of wall board are excellent material for making bottoms for trays, as they are light, strong, smoothly finished, and practically waterproof. To give the tray greater strength and to prevent warping, three 1- by 1- or 1- by $\frac{7}{8}$ -inch strips may be nailed across the bottom at the center and ends. These should be allowed to extend flush with the sides of the tray, as they will then hold the trays slightly apart when they are stacked, thus insuring prompt penetration of the fumes in the sulphuring box and a good circulation of air over the partly dried fruit when the trays are stacked at night or during unfavorable weather.

An objection sometimes urged against sun-drying fruit is that it is a slow process, during which the fruit is exposed to insects which may deposit their eggs in it and to contamination by wind-borne dust and dirt. While this is measurably true, it may be pointed out that fruits sulphured prior to drying, as are apricots, pears, peaches,

apples, and some varieties of grapes and figs, are not visited by insects during drying. Access of insects to the drying fruit may be prevented by cutting pieces of muslin or cheesecloth somewhat wider and longer than the trays themselves, stretching one of these tightly over the top of each tray after it is filled, and fastening it in place with carpet tacks pushed into the edges of the frame. Pieces of wire window screening may be used for the same purpose, and, although more expensive, they are much less troublesome to apply.

A good deal can be done to minimize contamination from dust by locating the drying yard judiciously. In large-scale sun-drying operations in California the drying yard is usually located on a recently harvested grainfield or a closely cut alfalfa field, at a considerable distance from roads, bare areas, and other sources of dust, and the trays are placed directly on the ground. In the more humid regions of the country it is not advisable to follow this practice. Instead, an area covered with a good stand of grass and located as far as possible from roads and sources of dust should be selected, the grass closely mowed, and an elevated platform or scaffold raised several feet above ground level built to receive the trays. This may consist merely of two or more rows of posts driven into the ground with pieces of 1- by 4-inch scantling spiked to their tops as supports for a row of trays placed side by side. This arrangement permits the free movement of air currents beneath as well as over the trays, which will materially hasten the drying. Some operators attempt to hasten the drying further by tilting the trays and supporting them in an inclined position so that the sun's rays may fall more nearly perpendicularly upon them. This necessitates the rearrangement of the trays two or three times during the day as the sun changes position, and it is doubtful whether the results always repay the time and labor involved.

Except in the hottest and driest localities it is necessary to stack the trays overnight, as the humidity during the night rises sufficiently to stop the drying and to result in condensation of moisture on the surfaces of the fruit. They must also be stacked on the approach of rain. Pieces of canvas or watertight wooden covers should be provided for use at night or in case of rain if it is not convenient to move the trays under cover of a porch or shed roof.

A modification of the usual method of sun-drying, known as shade or stack drying, is employed with excellent results in some of the fruit-drying districts of California, and might be successfully adopted in other regions having periods of very hot, dry weather during the drying season. The trays of fruit are exposed to direct sunshine for 1 or more days after preparation, until the fruit has lost about half its original weight. The trays are then stacked, sometimes with bits of scantling placed between them to increase the width of the interval and promote air circulation, and are allowed to remain in the stack until the drying is completed. Where the evaporating power of the air is sufficiently great to permit its use this method has the advantages that the fruit dries more evenly with less darkening and loss of flavor and, in the case of apricots and peaches, with a more uniform deep-yellow color and that there is less contamination from dust. For these reasons the stack method

is worth trying in any district having fairly low humidity, high temperatures, and considerable wind movement during the drying season.

DRYING WITH AN ELECTRIC FAN

In districts having cheap electric power an electric fan may be used to supplement sun-drying. After the material has been exposed to the sun until partly dry, several trays may be stacked one upon another, separated by bits of wood so as to permit free air movement over and between them, and the fan placed at one end of the stack so as to drive a current of air over the trays. As this is merely the stack method of drying just described, with a modification that keeps the air moving rapidly over the material, it is obvious that the rate of drying will depend upon the humidity of the atmosphere, consequently a fan will not be of much service during periods of high humidity and rainfall no matter how high the temperature may be, since the air is not then capable of taking up much additional moisture. Nor will the drying go on rapidly in a closed room, since the water evaporated from the material will progressively saturate the atmosphere and ultimately stop the process. Best results will be obtained from the use of a fan if the trays can be stacked on an open sunny porch and the fan so placed as to supplement the prevailing wind movement. As the material will dry most rapidly at the end nearest the fan, it will be necessary to reverse the stack of trays occasionally to equalize the drying. At best, the use of a fan can only supplement sun-drying and should not be undertaken in districts or at seasons when climatic conditions make sun-drying hazardous or impossible.

SOLAR OR OUTDOOR DRIERS

In districts having fairly continuous sunny weather but only moderate temperatures during the drying season it is possible to hasten drying considerably by the use of a solar drier. The principle involved is exactly that which is made use of in the coldframe or forcing box in which young plants are started in early spring. The drier is essentially a well-ventilated box with an inclined glass top so located that the rays of the sun fall directly upon the glass for as many hours as possible every day. The box receives the heat from the sun's rays more rapidly than it is lost by radiation to the surrounding air, with the result that the internal temperature in bright sunlight rises very decidedly above the outside air temperature. The capacity of the air to absorb moisture is increased as its temperature rises, as pointed out on page 3. Warm air is lighter than cold air; consequently if a glass-covered box exposed to sunshine is provided with air inlets near the bottom and an outlet at the top, a constant current of air will enter at the bottom, rise as it becomes warmed, and escape at the top. If the air is forced to flow over the surface of wet material in the course of its passage, it will take up moisture, and the material will dry more rapidly than if it were exposed in the open air.

A very satisfactory solar drier may be made from an ordinary window sash and a packing box having a length 2 inches less than that of the sash, a breadth 3 to 4 inches less, and a depth of 20 to 24

inches. Remove the boards from the longer sides of the box, leaving the ends and bottom fastened together. The ends must now be cut off so as to give the top the desired inclination. Measure off 10 inches from the bottom of the box along the edges of the end pieces at one side; upon the opposite side measure off 20 inches; draw a line between these points, and saw off the ends along these lines. This gives a frame for a box 20 inches in height at the higher side or back and 10 inches high at the front. Select from the boards removed from the sides two straight-edged pieces each about 4 inches wide; nail one

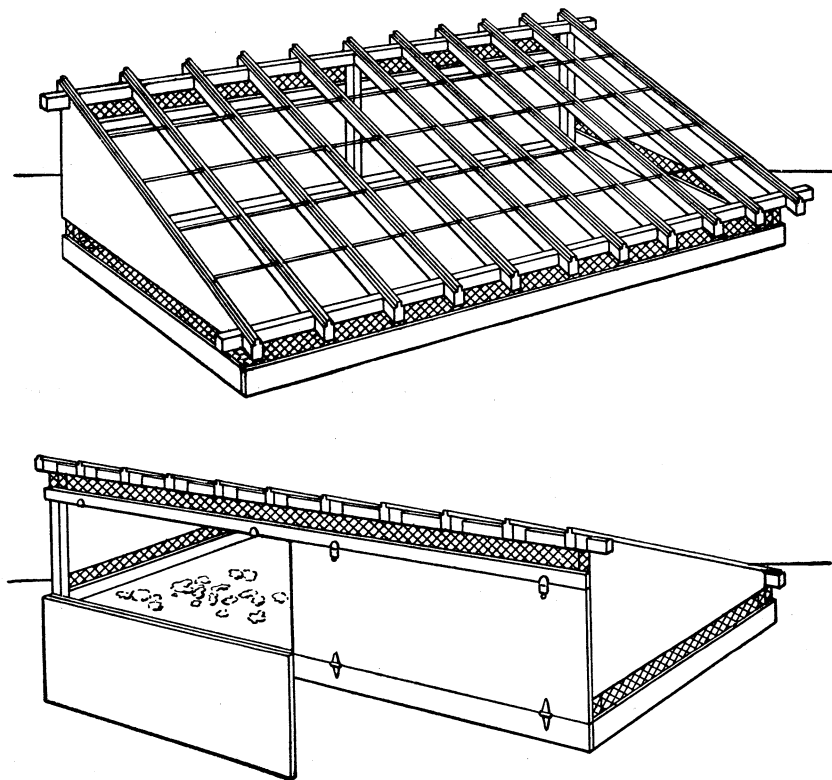


FIGURE 4.—A solar drier that protects the contents from dust and insects while shortening the time required for drying.

of these to the two end pieces at the back, with its upper edge exactly flush with the upper edge of the end pieces. Now lay the sash in place and nail the second long strip in place at the top of the front of the box, taking care that the sash makes close contact at all points with both sides and ends. At the back of the box measure off 6 inches from the lower edge of the top board; leave this space open to serve as a ventilator and board up the remaining distance solidly. There is a similar 6-inch open space at the front between the top board and the floor of the box, which is also to serve as a ventilator. Cover both ventilating openings with close-meshed wire cloth, such as one of the better grades of mosquito-proof netting, turning in the

free edges so as to give a smooth surface that will not catch the clothing of the operator. Attach the window sash by two light hinges to the strip forming the top of the back of the drier, so that it may be easily raised and lowered to get at the contents. With a plane go over all surfaces upon which the sash rests, smoothing them down so that the sash fits closely, to exclude insects, and the drier is complete. For convenience in handling the material a tray fitting into the bottom of the box may be made, or the products to be dried may be spread upon papers or canvas placed upon the bottom boards.

Such a drier should be placed where the sunlight will fall directly upon the sloping glass surface for as many hours as possible each day, and the drying will be accelerated if the position of the box is changed two or three times daily in accordance with the movements of the sun, as the absorption of heat is much greater when the rays fall directly upon the glass surface than when they strike it obliquely. If the sash is carefully looked over at the beginning of the season and any breaks in the putty repaired so that no water can reach the contents even in hard showers, the drier may be permanently located at some convenient place in the open.

Figure 4 shows a larger and somewhat more elaborate form of the solar drier which has a permanent watertight cover of glass put on in the same manner as a greenhouse roof. The higher or back side of this drier is made in two sections which are hinged at the bottom to form doors which drop down out of the way when trays are to be inserted or removed. The details of construction are apparent from the figure.

The reader should bear in mind that the solar drier, like the electric fan, is strictly limited in its usefulness by weather conditions. It will be useful in a region that has fairly continuous sunshine even though temperatures are moderate and humidity fairly high, since it utilizes the sun's rays to warm the air and thus increase its moisture-absorbing capacity; but it becomes useless, regardless of temperature and humidity conditions, as soon as the sun ceases to shine.

DRYING WITH ARTIFICIAL HEAT

If the conditions of temperature, sunshine, and rainfall that usually prevail during the period when drying is to be done are such as to make it clear that sun-drying cannot be depended upon, some type of artificially heated drying apparatus must be provided. In choosing a drier regard should be had (1) for proved convenience and economy of operation and (2) for suitability both in capacity and in first cost to the quantities of material to be dried. Obviously it would show just as poor judgment to provide an expensive evaporator to work up a few dollars' worth of raw material as it would be to attempt to dry the fruit from a good-sized orchard with a family-size drying machine.

There are available on the market a considerable number of evaporators or dehydrators, ranging in size and capacity from devices holding only a few pounds of material at a loading and designed to be placed on a cookstove or a gas burner up to those with capacities measured in hundreds of pounds. Those who desire to purchase ready-built equipment have simply to choose the size

and type of machine that seems best adapted to their particular needs. It is by no means necessary to purchase such equipment in order to make satisfactorily dried products. It is quite possible for one who feels the desirability or necessity of keeping his investment in an evaporator down to the minimum and who is able to use ordinary tools to build his own evaporator at very slight cost aside from time and labor. For the benefit of those who desire to do this, several types of evaporators are described in the following pages in sufficient detail to enable an ordinary workman to build them. They are purposely so planned that size and capacity may be adapted to the needs of the individual builder.

For the benefit of those who are inclined to doubt whether these relatively simple home-constructed devices are comparable with commercial equipment in efficiency and in quality of product, two or three facts may be pointed out. Increased efficiency of operation and heightened quality of product do not necessarily follow from the use of elaborate and expensive equipment. No drying machine can do more than merely contain the material while its moisture is removed by currents of warm air. Various devices may be employed to hasten the process, to increase the efficiency of the fuel used, and to give more complete control of temperature and humidity, but the essential principles of all these devices have long been understood and are utilized in the driers herein described. The quality of the product made with any type of equipment depends upon the grade of raw material used, the use of proper methods of preparation, and the exercise of care and good judgment in operating the drier.

COOKSTOVE DRIERS

When the quantity of material to be dried is limited to supplies for family use, a drier of such size that it can be heated by being placed on top of a kitchen range or heating stove will usually have the needed capacity. The general appearance and much of the details of construction of such an evaporator are shown in figure 5. The outside dimensions of this particular evaporator are, length 30 inches, width 14 inches, height 27 inches, which is about as large as can be placed on a range of ordinary size without interfering with cooking operations. The length and width may be varied to suit individual needs, but it would be a mistake to increase the height, for the reason that drying becomes progressively slower toward the top.

The frame of the drier is constructed of light 1- by 2-inch wooden strips. The frames for the two sides are made by cutting four 24-inch pieces and four 26-inch pieces from strips of 1- by 2-inch board and nailing them together to form two rectangular frames each 24 by 30 inches. Supports for the trays are then provided by cutting 1- by 1-inch strips 30 inches long and nailing them on the frames. The proper positions for these should be determined by marking them off with a carpenter's square, beginning 4 inches from what is to be the bottom of the drier. As the drier accommodates 8 trays, the supporting strips are placed 2½ inches from center to center, leaving a space of 3 inches above the topmost cleat. The frame of the box is then completed by setting the frames of the two sides on edge 12 inches apart and fastening them together by means of 1- by 1-inch

strips 12 inches long. Two of these are used at either end, at the top and bottom, and are fastened in place by nails driven through the corners of the frame into the ends of the strips. To give greater rigidity and better support for the walls, a third cross strip should be placed at either end about midway of the height. Its upper edge should be flush with those of the cleats supporting one of the trays in order that it may not be in the way in inserting and removing trays.

The drier is now ready to be covered. The walls and top may be made of light, thin lumber such as is used for packing boxes, of

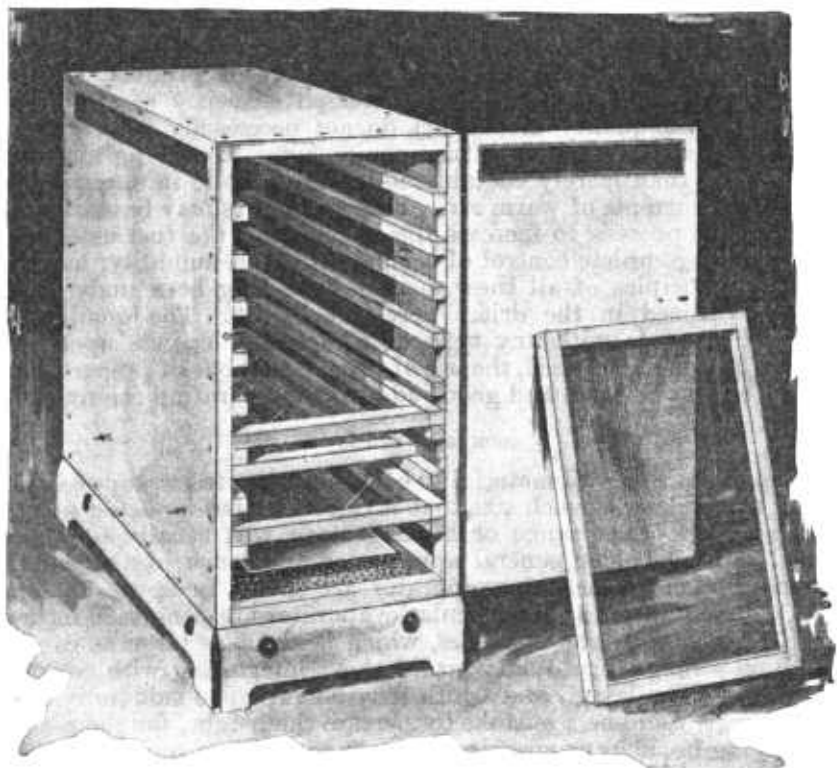


FIGURE 5.—An efficient and inexpensive home-made cookstove drier.

wooden pulpboard, or of tin or light galvanized iron. The use of metal has the advantage that it avoids the danger of fire. The denser medium-weight wall boards have the advantage that they are light, do not warp, and are very readily and quickly applied. Thin boards of nonresinous wood are usually available in the form of packing boxes or crates. Whatever the covering material used, the top of the drier should be covered over solidly to prevent accidental dropping of heavy objects or of dirt into the interior. The covering of the sides and rear end is begun flush with the bottom of the drier and is carried up to the level of the topmost tray support. This leaves an opening 3 inches wide between the walls and top of both sides and the rear end of the drier to allow for the escape of moist

air from the interior. This opening is to be covered with a substantial quality of wire mosquito netting, and the entire bottom of the drier is also to be covered with wire netting. This serves to exclude insects and small animals at such times as the drier has to be removed from the stove while filled with partly dried material or is not in use.

The door may be made of the same material as the walls and top. A ventilating opening 3 inches wide should be made across the top of the door, as shown in figure 5, and should be covered with netting like that on the other sides. To insure against warping, the door should be strengthened by cross strips of 1- by 1- or 1- by 2-inch wood at the top and bottom, or by two strips extending from top to bottom and meeting in the center to form an X. These are placed on the outside of the door so as not to interfere with its closing. Two light box hinges and some form of latch that will hold the door tightly closed are added, and the door is complete.

A base for supporting the drier a few inches above the surface of the stove to admit air and prevent overheating is necessary. Such a base may be very readily made from two pieces of heavy strap iron 24 inches long, by drilling holes in the central portion of each to take nails, and nailing them across the bottom of the drier at the front and back with the ends projecting 5 inches beyond the sides of the drier. These projecting ends are then bent downward nearly at right angles so as to form legs for the apparatus. Such a base may be made with less labor than that shown in the illustration (fig. 5), which is made of medium-weight galvanized iron. Strips of the iron 6 inches wide and an inch shorter than the sides and ends of the drier are cut, 1 inch of one edge of the strip is bent over at right angles, and a portion of the other edge is cut away as indicated in the figure. The strips are then nailed through their bent edges to the bottom of the drier and flared outward slightly to support the weight.

If the drier is to be used only upon a wood or coal stove, the entire bottom is left open except for the screen to exclude insects. If it is to be used over a kerosene or gas burner it will be necessary to provide a radiator or deflector to protect the lower trays from the direct flame and to distribute the heat. Such a radiator may be made of a sheet of fairly heavy galvanized iron, 2 inches less in width and length than the inside dimensions of the drier, and supported on twenty-penny nails driven about half their length into the frame of the drier along sides and ends. The deflector should be placed at least 4 inches below the bottom of the lower tray. The use of such a deflector has the disadvantage that since air can enter the drier only around its edges, there is necessarily a tendency for air currents to move upward along the sides and ends of the box, leaving the air in the center relatively stagnant and resulting in unequal rates of drying at sides and center. However, this tendency can be overcome to a very considerable extent by the alternating arrangement of the trays to be described in the next paragraph.

Make trays of a good quality of galvanized netting having a $\frac{1}{4}$ - or $\frac{3}{16}$ -inch mesh, cutting the bottoms 1 inch larger each way than necessary, and turning over the margins before fastening them to the frames, with the inturned edge next the wood. This prevents

injury to the operator by the cut ends of wires. Make frames for trays of $\frac{3}{4}$ - or 1-inch slats, fastening the netting to them with wire staples. If preferred, a reversible tray may be made by turning the tray over and nailing a second set of strips to the first. This gives a firmer support to the bottom and permits the tray to be used either side up, which is desirable in larger-size trays as a preventive of sagging, but is scarcely necessary in small trays. It is strongly recommended that the trays be made 3 or 4 inches less in length than the inside depth of the drier. When the drier is filled with material the bottom tray is pushed back as far as it will go, thus leaving an open space in front; the next tray is inserted only far enough to permit the door to close; the third is pushed back like the first, and so on. This arrangement of the trays effectively overcomes the tendency of the air currents to move upward along the walls of the drier and compels it to flow over the surfaces of the trays as well as through them, and thus hastens and equalizes the drying throughout the machine. It also partially overcomes one defect that is inherent in all driers of this type. Since air enters only at the bottom and escapes only at the top, it necessarily follows that the rate of drying is greatest at the bottom and progressively slower at the top, for the reason that the air is absorbing moisture and becoming cooler as it moves through the machine. If air currents were forced to rise through the trays with no opportunity to flow over them, as would be the case if no free space were left at the ends of the trays, movement might be so sluggish that the air would become saturated before reaching the top of the machine. Under such conditions the material on the upper trays not only would not lose moisture but might actually gain moisture by cooling the air and so condensing water vapor upon the fruit. It is to avoid such results that limits have been prescribed in the preceding paragraphs for the height of the drier and the number of trays and that the alternate arrangement of trays in the drier is advised. Notwithstanding these precautions, the rate of drying will decrease somewhat toward the top of the drier. The operator can equalize the process by shifting the position of trays in the drier from time to time and by inserting fresh material near or at the bottom of the machine.

The drier just described has eight trays, each having an area slightly less than 2 square feet, or a total of 16 square feet. As each square foot will accommodate $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds of material, the machine will have a capacity of 24 to 40 pounds at a loading. This is ample for the needs of the average family drying for its own use. In some cases it may be unnecessarily large, in which event the dimensions may be reduced, preferably by reducing the height and number of trays and secondly by decreasing the length of the machine.

A MODERATE-SIZED OUTDOOR OR PORTABLE TUNNEL EVAPORATOR

In many instances the quantity of material to be dried exceeds the capacity of any apparatus that could be operated over a stove or range in the kitchen. This will be the case on many farms that have a surplus of fruits, as, for example, apples, which the owner desires to evaporate for sale, or in cooperative or community kitchens

that are preserving perishable foodstuffs for a group of individuals. Often it will be the case that the quantity of material is not large enough to justify the purchase or construction of an evaporator of standard commercial size or the provision of a building devoted entirely to the work. In such cases the need would be best met by building a self-contained evaporator unit of the desired capacity, so constructed that it can be placed during the working season in any available workroom or even out of doors and subsequently removed to any convenient place of storage. Many attempts have been made to devise evaporators that meet this need. The evaporator here described appears to combine in somewhat greater degree than any of the others the required characters of cheapness, simplicity of construction, portability, efficiency in operation, and adaptability to the drying of a wide range of materials. It can also be built in a range of capacities to meet varying needs.

The tunnel or prune-tunnel evaporator owes its name to the fact that it was originally developed primarily for use in drying prunes in the more humid prune-growing districts of the Pacific coast. The principle of construction that made it especially desirable for handling that fruit has since been found to be equally advantageous in the drying of all sorts of products and has come to be widely used in driers for various purposes. This principle differs fundamentally from that of the cookstove drier and similar box driers, in which warm air is introduced at the bottom of a stack of trays and forced to travel upward through layers of wet material before it can escape. In the tunnel evaporator the chamber containing the trays is tilted from the horizontal so that the trays form a series of inclines extending from the lower to the upper end. Warm air is introduced at the lower end in such manner that instead of rising through the trays it moves freely over their inclined surfaces to escape at the upper end. This arrangement insures freedom from stagnant air pockets by providing a natural draft through all parts of the drying chamber.

The general appearance and some of the details of construction of a portable outdoor tunnel evaporator having a capacity of approximately 250 pounds of fruit at a loading are shown in figure 6. Additional details of construction will be made clear by reference to figure 7, which shows part of the interior of a tunnel drier of the same construction but of greater length and capacity.

The drying chamber of the evaporator shown in figure 6 is 5 feet in length, 32 inches in inside width, and 4 feet 6 inches in height. To give room for the heating arrangement beneath it and to give the desired inclination, it is elevated 3 feet above the ground at the front or door end and 3 feet 10 inches at the rear. It is built on a frame of 2- by 4-inch pieces, one at each of the four corners, which extend below the chamber to form supporting legs. The floor and ceiling of the chamber have a pitch of 2 inches per foot of length toward the front or door end, and the 1- by 1-inch strips that support the trays are given a like pitch. In order that the trays may fit snugly against the side walls and thus prevent leakage of air past their edges, the side walls are nailed to the inner side of the frame instead of the outer side, as in ordinary construction. For a drier 5 feet in length, sufficient rigidity will be given the side walls by

using a single 1 by 2 studding midway between the two corner posts and nailing them to similar pieces placed across the bottom and the top to serve as sills and joists for floor and ceiling. Walls, floor, and

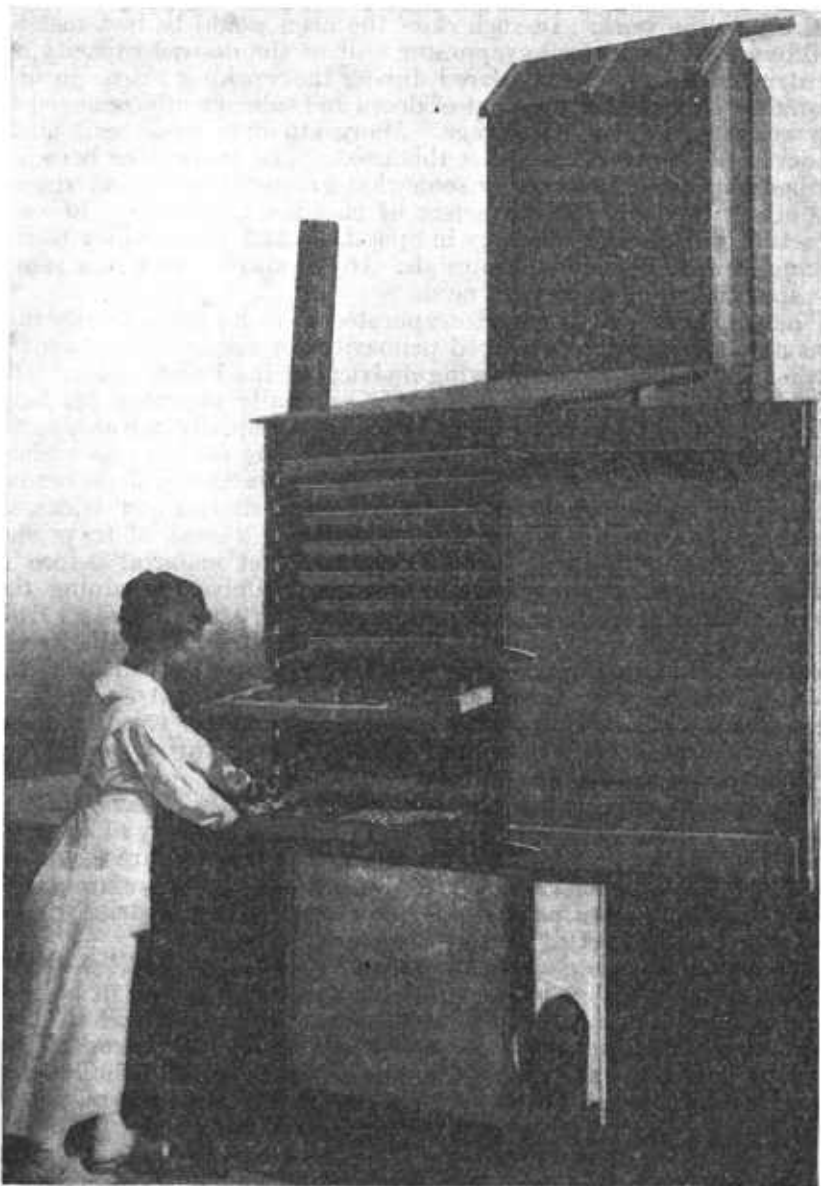


FIGURE 6.—A moderate-sized tunnel evaporator, suited for family use.

ceiling should be of tongue-and-grooved flooring lumber, and the planks should be closely driven together as they are put on. The runways for carrying the trays should be 1- by 1-inch strips of some

wood that does not readily warp or splinter and should be planed on the upper surface to promote the easy insertion and removal of the trays. Their positions should be carefully measured and marked on the walls to insure accurate spacing and uniform pitch, since these largely determine the efficient functioning of the evaporator. The topmost runway should be placed with its upper edge 5 inches below the ceiling in order to give an air channel $3\frac{1}{2}$ to 4 inches in height above the topmost tray. The remaining runways are spaced $3\frac{1}{2}$ inches apart on centers, which gives a capacity of 14 trays with a clear space of $3\frac{1}{2}$ to 4 inches below the bottom tray.

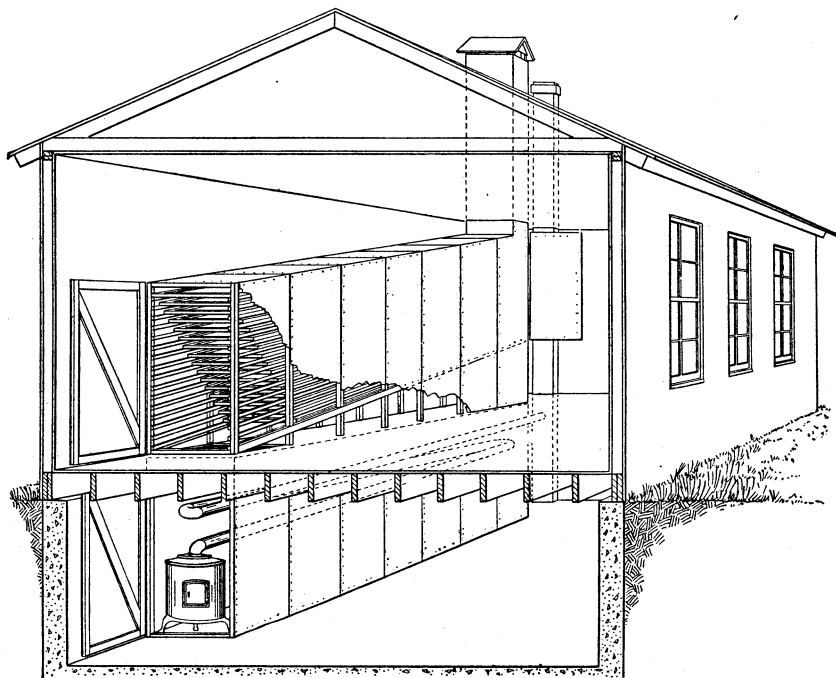


FIGURE 7.—A single-tunnel prune evaporator of standard dimensions.

A ventilating stack is provided at the upper or rear end of the drier. It should extend entirely across the end, should be at least 1 foot wide, and should be carried up to a height of 5 to 7 feet above the top of the drier in order to give a good draft through the drying chamber. It should be roofed over in the manner indicated in figure 7. The roof is extended 6 to 8 inches beyond the walls of the ventilator on either side, and an opening 5 or 6 inches wide left beneath this overhang to permit outflow of air. This arrangement prevents the entrance of rain or dust and also keeps wind from interfering with the draft. At the opposite end of the evaporator an opening 18 inches wide and extending across the width of the drier is left in the floor for connecting with the casing of the heating device. The remainder of the floor and the entire rear end are solidly boarded up with tongue-and-grooved lumber like that used for the sides and top. The entire front end opens by a single door,

which should fit closely and should be reinforced by bracing strips against warping and consequent air leaks.

It is scarcely necessary to point out that the effective operation of the drier depends upon making walls, floor, and door as nearly airtight as possible, so that air enters the chamber only from the heating chamber. Stray currents of cold air entering through cracks in the walls or around the door lower the temperature of the drying material, interfere with the normal distribution and movement of the warm air, and produce exasperating inequalities in the rate of drying. Hence, special attention to making all joints airtight will yield dividends later when the machine is put into operation.

If the drier is to be operated in the open air, as will be the case in many instances, it will require some protection against rains, which would wet the top and walls and cause warping. This may be effectively prevented by covering the whole outer surface of the top, side walls, door, and ventilating shaft with a fairly heavy grade of composition roofing. This will repay its cost and the labor of applying it not only in the longer life of the machine but also in the decrease in consumption of fuel resulting from its insulating properties. When such a covering is to be applied it will be possible to use one of the heavily compressed, tough types of wall board for the walls and top, as these are perfectly satisfactory if the joints are made to fit tightly and protection from weather is provided.

As the drier in most cases will be heated by a wood-burning or coal-burning stove, the height of the lower end of the drying chamber above the ground in the preceding description was stated as 3 feet, which is sufficient for any ordinary type of stove of the size required for heating the drier. An ordinary wood-burning heating stove of the rectangular box type, 20 to 24 inches long by 16 inches high and 12 to 14 inches in width, or a "cannon" stove, 24 inches in length and 12 inches in diameter, will furnish adequate heat, as will any similar stove that would heat an ordinary-sized living room. The essential features of the stove are that it should be of the end-door type and that its top should be at least 15 inches from the bottom of the drying chamber. The stove is centrally placed beneath the opening in the floor of the drying chamber, with the door toward one side of the drier. The pipe is carried out by short elbows at the opposite side, extended upward for a sufficient distance to prevent annoyance of the operator by the smoke, and is provided with a suitable support.

For enclosing the stove a fireproof casing must be provided. This may be made of galvanized iron riveted to a frame of light strap iron. The case should be equal in width and length to the opening in the floor of the drying chamber and of sufficient height to bring the upper edge flush with the floor of the drier, and there should be an opening at least 4 inches in width between the lower edge of the sides and the ground in order to permit the free entrance of air around the sides of the stove. If a cannon stove of the type described above is employed, an opening may be made in the end of the case of such size as to permit the end of the stove to fit into it. If a stove of some other type is used the end of the case must be hinged to serve as a door. The top of the stove case is fitted snugly into the opening in the floor of the drying chamber made to receive it.

As a considerable amount of ashes and smoke would otherwise be carried up into the drier when the stove door is opened to add fuel, it is well to provide a sliding panel to close the opening in the floor of the drier when the fire is being mended or the ashes removed. This may be merely a thin sheet of galvanized iron or a light wooden door, large enough to close the opening completely and provided with a handhold for convenience in moving. It may lie flat on the floor of the drier, being pulled forward over the opening when needed and pushed back out of the way at other times. Two parallel wooden strips nailed to each of the side walls a little more than the thickness of the slide apart will serve as supports and guides, making it certain that the slide closes the opening properly when in use.

Trays for use in the evaporator are made of $\frac{1}{4}$ - or $\frac{5}{16}$ -inch galvanized-wire netting stretched tightly on a frame made of 1- by 1-inch wooden strips. As the inside width of the drier is 32 inches, the tray frames are made $31\frac{1}{2}$ inches wide to permit easy insertion and withdrawal. The length should not be greater than 40 or 42 inches. (The additional 18 or 20 inches of length of the drying chamber permits an arrangement of the trays that secures uniform distribution of the warm air, as subsequently explained.) The wire netting should be cut about 1 inch wider and longer than the finished tray is to be, and about one half inch of the edge should be turned back all around to give additional security to the attachment to the frame. Stretch the netting as tightly as possible on the frame, attach it with light staples, then place a second frame on top and nail the two together through the edges of the wire. This makes a reversible tray which may be further strengthened by cross strips of the same material as the frame placed at the middle. If turned over occasionally, such a tray will give many years of service without sagging.

Although the drier here described holds 14 trays, it is an excellent plan to have an additional set of trays or at least a partial set made up and available. This will permit the loading of material while the drier is still filled with nearly dry material and will thus make the operation of the drier more nearly continuous.

When the drier is being loaded the first tray is placed on the bottom runway and pushed back until its nearer edge is just flush with the inner edge of the opening of the heating chamber. The next tray is pushed back until its nearer edge projects about $1\frac{1}{2}$ inches over that of the first; the third is allowed to project a like distance over the second; and each succeeding tray is placed so as to stand out for the same distance beyond its fellow immediately below. The effect of this offset arrangement is indicated in figure 7, which shows a cut-away view of the lower end of a loaded drier. Its purpose is obvious from the preceding discussion of the basic principle of this drier; the projecting edges of the trays act as a series of baffle plates, breaking up the ascending current of warm air and distributing it through the series of trays in such fashion that drying occurs at practically identical rates at the top and bottom of the evaporator. At the opposite end of the drier the moisture-laden air between any pair of trays has a perfectly free path of escape upward into the ventilator, so that dead-air pockets cannot occur.

It will usually happen that material is being prepared and placed in the evaporator more or less continuously throughout the day.

Such fresh material should always be placed on the upper runways, that which is nearly dry being shifted downward. There are good reasons for this; the freshly prepared material cannot endure as high temperatures as that which is partially or nearly dry, and the slightly lower temperature near the top of the evaporator, together with the fact that the rapid escape of moisture from the fresh material keeps it cooled considerably below the air temperature, prevents injury from overheating. The partially dry material gives off its moisture much more slowly, and its drying will proceed more efficiently if it is completed at as high a temperature as the material will safely endure. Consequently, drying should be begun in the coolest and finished in the hottest portion of the drier.

The foregoing description assumes that the evaporator will be set up in the open air and heated by a wood- or coal-burning stove. In some cases it will be convenient and desirable to operate the evaporator inside an existing building, in which case it is of course unnecessary to provide watertight covering for the drying chamber, which might be constructed of wall board with battens fastened over the joints to reduce air leakage. In other cases steam for heating the drier may be available from a boiler already in use for other purposes, as where canning is carried on in connection with drying. Where available and not prohibitively expensive, steam should be employed because of the resulting freedom from dust and smoke and the better control of temperature. In such a case the stove is replaced by heating coils of 1- or 1½-inch steam pipe placed beneath the floor opening of the drying chamber and boxed in by board walls having good-sized ventilator openings so placed that the entering air is forced to flow over and between the heated pipes. If electric power is available, a fan may be used to drive a current of air through the radiator coils, thus increasing the rate and volume of air movement. In working out these or other desired modifications of the general plan of the evaporator the individual builder may work with a free hand, provided he is sure that he understands the fundamental principles of construction and operation of the tunnel evaporator as stated on page 19 and that no change he proposes to make will do violence to these principles.

A COMMERCIAL-SIZED TUNNEL EVAPORATOR

Individual growers who have a considerable acreage of fruits, or community cooperative organizations in fruit-growing districts, will have need of an evaporator of larger capacity than that just described. In such cases a tunnel evaporator of larger size may be built. While the lower limits of the size of a tunnel may be determined by the capacity required or by the size of the heating unit that is available, there is a definite upper limit which cannot safely be exceeded. A single tunnel should not be made more than 18 or 21 feet in length, 6½ feet in height, and 3 to 4 feet in width. Three feet of the length of the tunnel will not be occupied by trays, as it is left free to aid air movement, as explained on page 23. Such a tunnel will accommodate 16 tiers of trays placed 4 inches apart, which will give a total drying surface in a tunnel 21 feet long of 864 square feet if the tunnel is 3 feet wide, or 1,152 square feet if its width is 4 feet. As each square foot of drying surface will accommodate 1½

pounds of thinly spread material or 2 to 2½ pounds of less delicate products, this will give a capacity of 1,300 to 1,900 pounds of green fruit at a charge for the 3-foot width, or one third more for the 4-foot width. If the quantity of material to be handled is larger than can be cared for by a tunnel of this capacity, a second unit should be built, as it has been clearly demonstrated in practice that a natural-draft tunnel drier cannot be made larger or longer than the limits stated without material loss in drying efficiency.

The larger- or commercial-sized tunnel depends for its efficiency upon exactly the same principles as the smaller unit previously described—namely, the introduction of warm air at one end of the drier and provision for its escape at the other, an arrangement of the trays that distributes the warm air currents throughout, and the inclination of the drying chamber to facilitate air movement over rather than through the material and thus to prevent air pockets. Its only essential difference is that its capacity is increased by increasing its length. In consequence there is a considerable difference in temperature between the lower and upper ends of the tunnel, and this difference is utilized by providing doors at both ends, inserting fresh material only at the upper and cooler end, moving it downward as drying proceeds and it becomes able to withstand higher temperatures without injury, and finishing the process at the lower and hotter end of the tunnel. In all the details of construction the larger-sized tunnel is identical with the smaller one already described, so that they do not require repetition.

By reason of its size the standard tunnel evaporator cannot be portable and must be constructed where it is to remain. For its installation it requires a 2-story building or a single story with a basement, or at least an excavation that will accommodate the furnace or heating arrangement. The drying chamber or tunnel is placed above the floor line, the heating device below it (fig. 7). The building that is to house the drier must be of sufficient length not only to accommodate the tunnel but also to give a clear area of 5 to 6 feet at either end of the tunnel for convenience in inserting and removing trays.

When the drier is to be installed in an existing building, the floor should be taken up over an area equal to the width and length of the tunnel, which will have its own inclined floor. The framework of the drying chamber is then set up over this opening by nailing its members to the joists or to the floor of the room.

The frame of the tunnel should be made of 2- by 4-inch lumber spaced not more than 2 feet apart, in order to prevent warping and opening of the walls. For the same reason the walls and ceiling should be of good-quality tongue-and-grooved flooring, which should be closely driven together in building, or they may be of strong compressed pulpboard if the joints are made tight and reinforced by battens. In order to give the ceiling and the floor of the tunnel the necessary inclination of 2 inches to the foot of length, the studs at the lower end are cut 6½ feet in length, each successive pair is made 4 inches longer than those immediately preceding them, and all are spiked to the beams that supported the original floor (fig. 7). Pieces of 2- by 4-inch lumber are next nailed to the stud- ding at the proper height, thus forming supports for the floor of

the tunnel, which should be laid before the side walls are put on. The floor should be of tongue-and-grooved material to prevent the entrance of ashes and dust from the furnace room. In all cases an opening 3 to 4 feet in length and extending across the width of the tunnel is left at the lower end, directly over the furnace, as an inlet for warm air.

Since the upper end of a 21-foot tunnel is 3 feet 6 inches higher than the lower end, it is necessary to surround the upper end with an inclined false floor leading up to the doors, in order to permit easy access with trays loaded with fruit.

If a single tunnel is being built, the sheathing of the side walls should be nailed to the inner surface of the studding, thus giving a smooth surface upon which cleats for carrying the trays may be nailed, leaving no spaces at the sides through which air may pass directly up. When two or more tunnels are built side by side the common walls should be boarded on both sides for the same reason. The side walls are continued down to the floor of the room in which the drier stands, thus forming a warm-air chamber beneath the floor of the drier.

The ventilating shaft extends entirely across the upper end of the tunnel and should be not less than 2 feet in width. It should be carried to a height of at least 3 or 4 feet above the roof of the building, in order to secure a good draft, and should be protected against wind or rain, as suggested on page 21.

The doors of the tunnel must, of course, open for the entire width and height and should be carefully fitted and provided with closing strips and a tight latch, so that air currents may not enter through them. If the tunnel is more than 3 feet wide, double doors meeting at the center of the opening will be more convenient than a wide single door.

The cleats carrying the trays are nailed directly to the side walls of the tunnel, with the same inclination as the floor and ceiling. The first pair of cleats are placed with their upper edges 6 inches above the floor line, and those above are spaced 4 inches apart from center to center. The cleats may be 1 or 2 inches wide, but should be a full inch in thickness in order to give a broad supporting surface for the edges of the trays, and great care should be used in selecting and placing them so that the upper edges form straight lines, as otherwise there will be difficulty in sliding trays along them.

In use the trays of fresh material are always inserted at the upper end, where they are allowed to remain from 1 to 3 hours. Each is then pushed down far enough to permit the insertion of a tray behind it, and this is continued at intervals until the runways are filled. A tunnel in operation consequently always has at the lower end trays of material that is nearly dry and that is receiving the full heat of the furnace, while behind these are successive tiers of trays each filled with material containing more water and surrounded by air of lower temperature and higher moisture content, the last tiers being filled with freshly prepared material that has not yet begun to dry and that is being slowly warmed up by currents of relatively moist air at moderate temperature. The advantages are obvious. The arrangement permits the insertion of new trays as rapidly as they are pre-

pared, and the overheating and injury of water-filled fruit are avoided, while the material is automatically moved forward into higher temperatures as rapidly as it becomes able to withstand them.

When the tunnel is completely filled there is a tendency for the heated air to travel between the lower trays, resulting in slower drying in those near the top of the drier. This can be overcome by offsetting the tiers of trays, as described in connection with the smaller tunnel on page 23. This is done by omitting one tray from each runway and so arranging the trays at the lower end of the tunnel that the edge of the lowest tray in the stack is just flush with the edge of the hot-air opening in the floor; the next projects 2 or 3 inches beyond the first, and each succeeding tray stands out for the same distance above its fellow immediately below, as shown in figure 7.

Two dependable thermometers should be in the drier at all times, one at the upper and one near the lower end. The person in charge of the furnace should so regulate the firing that the temperature at the upper end shows no sharp variations from that recommended for the particular material being handled when fresh, while that at the lower end is within the range permissible for finishing the drying.

A single tunnel 20 feet or less in length can be very satisfactorily heated with any stove large enough to heat comfortably a lodge room or store 20 by 30 feet in size. Some driers are very satisfactorily heated with a home-constructed wood-burning furnace built of brick or stone and having a top made of heavy iron set in cement. If such a furnace is provided with doors and draft controls, and the top and sides are gone over occasionally to close cracks that might permit the escape of smoke and soot, it is very satisfactory. If more than one tunnel is to be heated, a larger heating stove or a furnace of the type used in commercial drying plants should be secured. In such plants the tunnels are usually built in groups of three, the furnace is placed beneath the floor opening of the central tunnel, and the pipe is divided by a T-joint into two lines, which are carried out beneath the openings of the lateral tunnels and then brought once or twice around the furnace room before passing into the flue.

The furnace may burn either wood or coal, but both stove and pipe should be tight and in good repair, so that there will be no escape of soot and smoke, which would necessarily rise through the fruit above. The stove is placed directly beneath the opening in the floor of the tunnel at its lower end, and the pipe is brought up to within 3 feet of the floor and then carried at about that distance from the floor of the tunnel but with a slight upward inclination to the upper end, where it enters the chimney. The hot pipe thus serves to heat the floor of the tunnel. Since there must be free access to the end of the tunnel on the floor above, the chimney must stand at one side, or the pipe may be carried beneath the floor of the basement to a conveniently located flue, provided an upward inclination is maintained to prevent sooting up.

The furnace room may be an enclosure of the same width as the tunnel above it, or slightly greater, but it should be at least 2 feet longer, this additional length being located at the lower end, in order to permit the placing of the furnace immediately beneath the opening

in the floor above. If the tunnel is placed against the side wall of an existing building, the furnace room may be made by erecting partitions covered with rough boards or sheet iron to complete the enclosure, with a door for access in firing the furnace. Ventilator openings 1 foot in height and 3 to 5 feet in length should be left in each of the side walls at their middle point and just above the ground level, in order that the incoming cold air may pass over the heated furnace and piping before passing into the tunnel.

As the furnace stands directly beneath the opening in the floor of the tunnel, care must be employed in firing and cleaning the furnace, or ashes and soot will rise into the tunnel and be deposited on the drying material. Trouble from this source may be avoided by providing the opening in the tunnel floor with a sliding door of wood or sheet iron, which is closed when ashes are being removed but pushed back beneath the lower tray at all other times.

In cases in which a steam boiler is available, steam-heating coils may be substituted for the furnace, as suggested on page 19.

Trays for the drier should be built as described on page 23, making the dimensions 3 by 3 feet, or 3 by 4 feet if the tunnel is 4 feet in width. A considerable number of extra trays should be made up.

THE TUNNEL EVAPORATOR WITH AIR RECIRCULATION

Where electric power is available a modification of the tunnel evaporator developed at the Oregon Agricultural Experiment Station may be adopted, as it gives considerable increase in drying capacity with some decrease in fuel consumption. Its distinctive feature is an arrangement whereby the air is repeatedly reheated and recirculated over the fruit. This is accomplished by cutting an opening 2 feet square in the floor of the tunnel at its upper end and building a duct leading from this opening to a housing surrounding a fan, which is so placed in front of the furnace that it forces a current of air over the furnace and piping into the air inlets at the lower end of the tunnel. The air intakes in the walls of the furnace room and the ventilator at the upper end of the tunnel are provided with trapdoors, which may be closed or opened to any desired degree at will, and similar provision is made for admitting fresh air into the housing surrounding the fan. The furnace and piping are made tight by cementing or stripping the joints. When the fan is started the trapdoors in the ventilator are closed, and air that has passed through the tunnel is consequently forced to return through the ducts to the fan, whence it passes over the furnace to be again heated and driven over the fruit. As the temperature and the humidity of the returning air rise, the fresh-air inlet into the housing of the fan and the outlet to the ventilator are partially opened, so that some fresh air is continually entering, while a portion of the moist heated air is allowed to escape. With proper attention to the adjustment of these openings, the temperature in the apparatus may be kept rather constant. It should not be allowed to exceed 160° F. at any time, and it will be necessary to lower the temperature to 130° or 135° for an hour or two when fresh fruit is placed in the tunnel. This is done by opening the fresh-air inlet into the fan housing and the moist-air outlet of the ventilator rather wide, so that most of the moist air escapes. Unless this is done

there is danger of overheating the fresh material and producing cracking and dripping. As the fruit begins to dry the temperature may be gradually raised by adjusting the air intake and outlet to increase the amount of air recirculation in the apparatus.

PREPARING AND DRYING FRUITS

It is well known that the flesh of apples, peaches, pears, and apricots rapidly undergoes discoloration when the fruit is cut open and exposed to the air. The color changes are visible indications of the rapid chemical changes that are going on and that injuriously affect the composition, flavor, and odor of the fruit if permitted to continue. Exposure of the fruit to the fumes of burning sulphur is the most satisfactory method thus far discovered for arresting these changes, and it has been universally employed in the commercial drying of these fruits for many years. Although the treatment has been subjected to a great deal of criticism as being harmful to consumers, there is an entire absence of any evidence that consumers have ever received any injury to health from the use of sulphured fruits. It is rather firmly established that the sulphurous acid formed upon the moist surfaces of the fruit is progressively lost during drying and subsequently, and that the ordinary processes of cooking drive off most of the remainder, with the result that the amount taken by the consumer is too small to have any discoverable effects. The treatment with sulphur has the advantage of preserving natural color and flavor of the fruit and preventing souring and insect attacks during drying. It has recently been established that it very effectively protects the vitamins of the fruit against destruction during drying, while the vitamins of unsulphured fruit are almost totally destroyed. Consequently the practice has much to commend it, and there are no counter arguments supported by facts to be urged against it. The decision whether fruits intended for home use shall be sulphured is a matter to be left to individual preference; if they are intended for market they must be sulphured in order to be salable.

Dipping into a 1-percent solution of potassium metabisulphite or sodium bisulphite has been advocated as a substitute for the sulphuring process. It is much less satisfactory, as penetration into the tissues is slow and the fruit must be left submerged in the solution for 15 to 30 minutes, thus permitting the diffusion of sugar and other soluble constituents out of the tissues. It also permits the absorption of considerable amounts of water, which must be removed in the drying process, which is correspondingly lengthened. The same objection applies to dipping or soaking in warm salt water, which is sometimes recommended as a substitute for sulphuring. It is a very imperfect and unsatisfactory substitute, since it only temporarily prevents discoloration; also, sufficient salt is often absorbed to affect the flavor of the fruit. Dipping into hot water is still less satisfactory. If the dip is sufficiently prolonged to destroy enzymes and check oxidation and chemical changes, it at the same time kills the tissues and results in considerable loss of sugars by dripping. These treatments are mentioned only that the reader may be warned against employing them.

APPLES

Apples intended for drying should be reasonably mature but not soft, and should be handled with proper care in picking and hauling so as to avoid bruising, as bruised spots that have become discolored must be trimmed out in order to make a good-looking product. In preparing apples the working force must be so divided that the fruit is trimmed and sliced as rapidly as it is pared, as peeled fruit must not be allowed to remain standing in the air while awaiting its turn at the hands of the trimmers and slicers. After being pared and cored, the apples should be trimmed immediately to remove all bits of peel, discolored or decayed spots, and fragments of core, and at once sliced. Apples are usually cut by a special slicing machine into slices or rings at right angles to the core hole and one fourth inch thick, but a few individuals will prefer to cut them into quarters or eighths. Quartered apples, by reason of their greater thickness and the varying size of the pieces, dry more slowly and unevenly than slices, and hence reduce the daily capacity of the drier and require a greater expenditure of fuel per dry pound, for which reasons they are now rarely made in a commercial way.

If the fruit is to be sulphured it should be spread upon the trays to a uniform depth of 1 to 1½ inches as rapidly as it is sliced, and immediately placed in the sulphuring box for 20 to 30 minutes, after which it is transferred to the evaporator. In large evaporators where the fruit is sliced by power-driven machines it is sulphured after being pared and trimmed but prior to being sliced. If desired, this may be done; but since the operator of a hand-slicer would be forced to breathe the fumes of sulphur dioxide, it is preferable to slice the fruit prior to sulphuring it.¹

If the fruit is to be sun-dried, it should be spread much more thinly, not much more than two slices in depth, and the trays should be immediately exposed to the full sun. If conditions are favorable for stack drying, the trays may be stacked after 1 or 2 days of full exposure to the sun.

If the fruit is dried in an evaporator, drying should be begun at 130° F. and the temperature gradually increased to 175° F. The trays of drying apples should be examined from time to time and if necessary stirred with the fingers to correct any tendency to unevenness in drying. The fruit is sufficiently dry when a handful of slices gripped firmly in the hand has an elastic, springy feel; separates promptly when the pressure is released, and leaves no visible moisture upon the hand. It should be removed when this condition is attained and before the slices become crisp and hard, and subsequently treated as described under Treatment of Products after Drying (p. 45).

Different varieties of apples have very unequal value for drying, since they show great differences in the quality and appearance as well as in the yield of dry product. Generally speaking, varieties

¹ If the fruit is not to be sulphured, darkening can be prevented only by providing pails of water into which the fruit is dropped after being pared. Trimmers and slicers are also provided with such pails, so that the fruit is exposed to the air only while actually being handled by the workers until it is spread on trays and placed in the warm evaporator. If the fruit must stand in the water for some time before being spread, better preservation of color will be secured by adding table salt to the water at the rate of 3 to 5 teaspoonfuls per gallon.

that have good dessert or cooking quality make superior evaporated fruit, since the distinctive flavors are fairly well retained through the drying process. Most summer and early-maturing varieties give a low yield of dry product which, while light colored and attractive in appearance, is disappointing by reason of its very rapid deterioration in storage and its lack of sweetness and distinctive flavor when cooked. For these reasons later maturing autumn and winter varieties known to have satisfactory cooking quality should be selected for drying when there is opportunity for choice, not only because of the richer flavor, higher food value, and greater palatability of the dried fruit, but also because of the larger yield of dry product obtained from the money and labor expended upon a given quantity of fresh material. The Winesap, Stayman Winesap, Northern Spy, Jonathan, Esopus Spitzenburg, Grimes Golden (*Grimes*), Rhode Island Greening, Rome Beauty, Yellow Newtown, Delicious, Golden Delicious, Wagener, Roxbury Russet, and Golden Russet are varieties that make evaporated fruit of superior quality in point of flavor and sugar content. The color of dried fruit made from these varieties will vary considerably and in most of them will be somewhat golden. The Northern Spy and Esopus Spitzenburg are exceptions, as the dried fruit made from them compares favorably in color with that from the Baldwin and Ben Davis, which are favorites with commercial evaporators because they yield exceptionally white dried stock.

PEARS

The drying of pears on a commercial scale is practiced in the United States only in California, and the Bartlett is practically the only variety there employed for the purpose. So little attention has been given to the drying of any other variety, either in California or elsewhere, that there is very little definite information as to the quality of the product. It is known that such pears as Le Conte, Kieffer, and Garber yield very inferior dried fruit, and these varieties should be utilized in canning or in some other way. On the other hand, any variety with fine-grained flesh that combines fairly high sugar content with distinctive flavor may be expected to make an acceptable dried product. The methods of handling pears for drying, here described, are based upon those employed in handling the Bartlett in California.

The pears are picked when the fruit is still quite firm but readily loosened from the tree when slightly lifted with the hand. They are then stored in boxes or crates beneath a shed for a week or more until ripe but still firm. They are usually prepared for drying by having the stem and calyx removed; the pears are then split lengthwise into halves without either core or peel being removed, and spread on trays in a single layer, cut surface uppermost. A better product is made by removing the core and the central woody tissue; this is done by the use of a knife having a curved blade, a so-called coring spoon. In order to make a product having an attractive appearance it is necessary to continue the sulphur treatment for 3 or 4 hours or even longer. If the fruit is not sulphured it is necessary to keep it under water after it is cut as described for apples, until it can be spread and placed in the drier. Half pears

dry more slowly than apples, and, if preferred, fruit intended for home use may be cored and quartered, or peeled and cored and cut into quarters or eighths, which will facilitate drying and also reduce the time necessary for sulphuring. The temperatures to be employed in drying in the evaporator and the methods of handling in sun-drying are like those for apples. The properly dried product is elastic and rubberlike, and it is impossible to press water out of the freshly cut surface of the pieces. The treatment after drying is identical with that given apples.

PEACHES

Any of the varieties of peaches generally grown for table and market purposes in the Eastern and Southern States may be successfully dried, but it should be understood that the dried fruit will differ materially from the commercial evaporated peaches found in the markets. The commercial product is made mainly from yellow-fleshed freestone varieties, such as the Muir, Lovell, and Salwey, with smaller quantities of a few other varieties, all of which are practically unknown outside of California, where they are grown especially for drying. Their selection for this purpose is due to the fact that they combine uniform clear yellow color and attractive appearance when dry with a high content of solids, especially sugar, in consequence of which they give larger yields of dry fruit than other varieties. Among the varieties more generally grown in the humid regions, the Elberta, Belle, J. H. Hale, Champion, and Carman are more or less widely dried in small quantities for local or home use, but are considered as somewhat inferior for drying purposes to the older home-orchard varieties such as Early Crawford, Late Crawford, Reeves, Slappey, Crosby, Fitzgerald, Foster, Stump, and Oldmixon Free, all of which were at one time dried in considerable quantities.

Fruit intended for drying should be allowed to remain on the tree 2 or 3 days after the time at which it would be picked for market—that is, it should be fully ripe but not too ripe to be handled without becoming seriously bruised. Picking and loading should be carefully done to minimize the bruising of the fruit. Practically all commercially dried peaches are dried without being peeled. If the commercial method is followed, the fruit is thoroughly washed and split in half, and the stones are removed and the split halves immediately spread in a single layer, stone cavity uppermost on the trays. With the freestone varieties no difficulty in halving or stoning will be encountered. With clingstone varieties, one worker cuts the fruit in half by cutting along the suture line and extending the cut entirely around the fruit, while a second operator separates the halves from the stone by the use of a spoon-shaped pitting knife. As rapidly as trays are filled they are transferred to the sulphuring chamber, as discoloration sets in very quickly. The fruit is allowed to remain in the sulphuring box 2 to 4 hours, the exact time varying with the degree of ripeness and even more widely with the variety. The process is completed when the flesh takes on a rather uniform semitranslucent appearance and juice begins to collect in some quantity in the stone cavity. This necessitates careful handling in transferring the fruit from the sulphuring box to the drier, as this juice is rich in sugar and must not be lost by carelessly tipping the trays.

Great differences will be observed in the time required for drying. The criterion for sufficiently dried fruit is the pliable, leathery character described for apples.

If the fruit is being dried in relatively small quantities for home use, the operator may prefer that it be peeled before drying. If this is the case, the lye-peeling method described on page 8 should be used, employing a 10-percent lye solution heated to 135° to 140° F. If the variety is one that has little or no red pigment about the stone and radiating into the flesh from the stone cavity, it may be peeled prior to being halved and pitted. If the variety is one having considerable red pigment about the stone, the fruit should be halved and pitted before being peeled, in order that the warm lye solution may remove the pigment, which becomes nearly black during drying and gives the fruit a harsh astringent or bitter flavor if it is allowed to remain. After being thoroughly washed so that all traces of lye are removed, the fruit is placed, stone cavity up, on trays and sulphured for not more than 20 to 30 minutes. The reason for the shorter sulphuring period than that given unpeeled fruit is that penetration into the fruit is much more rapid, since it takes place from both sides of the pieces; also it cannot be made as complete as in unpeeled fruit or loss of sugar will occur through "weeping" or dripping from the outer surfaces. In order to secure uniform color without loss of sugar, it is a good plan to continue the sulphur treatment after the fruit is placed in the drier, by burning sulphur in a vessel placed on top of the furnace so that the fumes rise over the fruit. This permits the completion of the treatment without loss from dripping, as the moisture that exudes is evaporated. In sun-drying it is of course not possible to continue the sulphuring after drying begins, and the operator will have to determine by experiment with any particular lot of fruit how long the treatment in the sulphuring chamber can be continued without causing loss by dripping. The drying of unpeeled peaches in the evaporator should be begun at a temperature of 130° to 145° and gradually increased to 165° toward the end of the drying process. For peeled peaches the temperature used at the beginning should not exceed 125° to 130°, but may be raised to 165° as the fruit becomes nearly dry.

APRICOTS

Apricots intended for drying should be picked from the tree before they become ripe enough to drop. The handling of apricots in preparation for drying is like that given peaches, as outlined above, with the difference that the fruit is never peeled but is halved and stoned, and is sulphured for 1½ to 2 hours. Nectarines are treated in the same way. In apricots, as in peaches, a rich sirup collects in the stone cavities after sulphuring, and careful handling to avoid its loss in transferring to the drier is necessary. The temperatures to be used are the same as for unpeeled peaches.

CHERRIES

Sweet cherries, especially the dark, solid-fleshed varieties, such as the Black Tartarian, Bing, Lambert, and Dikeman, make a very acceptable product when dried and may be employed in the same

ways and for the same purposes as raisins. The sour or pie cherries are also easily dried.

The fruit is washed, picked over to remove stems and imperfect fruits, and then spread in a single layer on the trays and placed in the drier. If the fruits are very large they may be pitted before being dried, but large quantities of the juice, which contains a considerable portion of the sugar of the fruit, are lost in the process. If this juice, which amounts to 35 to 50 gallons per ton of fruit, can be saved and combined with apple or other juices in the making of jellies, pitting may be attempted; otherwise the process is both time-consuming and wasteful. While the practice is not generally employed, it has been found that the drying of whole cherries is considerably hastened and the quality of the dried product improved by dipping them for 20 to 40 seconds in boiling lye, as described for prunes in the next paragraph. This treatment partially dissolves the waxy coating, but its chief result is a cracking of the skin which facilitates the escape of moisture. The drier should not be hotter than 120° F. when fresh cherries are placed in it, and the temperature should never rise above 150°, as cherries are easily injured by overheating.

PRUNES

Prunes intended for drying should be allowed to become fully ripe and fall from the trees of their own accord, as such tree-ripened fruit is considerably richer in sugar than that obtained by shaking the trees. Three or four pickings will usually suffice to gather the crop. The fruit should be gathered into crates or boxes holding not more than a bushel and should not be allowed to stand in the crates more than 12 hours after it reaches the drier. In gathering, all partially decayed, overripe, fermenting, or soft fruit should be discarded.

The term "prune" is applied to several varieties of plums which are alike in that they may be successfully dried without the previous removal of the stones, but which differ in other respects. All the varieties that are commonly dried require a short immersion in boiling lye to remove the thick waxy coating and to check or crack the skin and permit the contained moisture to escape. (See p. 7.) The exact time for dipping will vary with the variety and also with the degree of maturity of the fruit, but will be about 35 to 45 seconds for immature fruit and not more than half that time for that which is fully ripe. The dipping is properly done when the fruit shows a very few fine checks over the surface and particularly near the point of attachment of the stem, but must not be continued until the skin is actually split or begins to peel off. The lye should be boiling, and the dipping basket should be moved about in the liquid to aid in bringing all the fruit into contact with the solution. The basket should then be quickly transferred to a large vessel of cold water and thoroughly rinsed to remove the lye, after which the fruit is spread in a single layer upon the trays. With the dark-fleshed prunes, such as the Italian Prune (*Fellenberg*) and the Agen (also known as the *Petite* or *French* prune), which, with the Imperial prune, constitute the principal varieties used for drying, no further treatment is given. Light-fleshed varieties, such as the Golden Drop (*Silver*) prune, require a short treatment in the sulphuring box immediately after the lye dip, in order to preserve the color. By rea-

son of their thick, waterproof skins, prunes are especially liable to burst if overheated at the beginning of drying. Consequently, fresh trays should always be placed in the coolest portion of the evaporator, and the temperature should never be allowed to exceed 140° F., and should preferably be 10° lower for the first 3 or 4 hours. As wrinkling of the surface begins, the temperature may be gradually increased and may rise to 175° without danger of injury as the fruit becomes nearly dry. Prunes are sufficiently dry when the flesh shows no moisture when torn across and pressed vigorously between the fingers.

PLUMS

There are very few available data showing the comparative value of the dry fruit made from the different varieties of cultivated plums, for the reason that these fruits have been dried only in a small way for home use. Of the Japanese plums the Abundance and Burbank give a good product when dried by the methods described below, the flavor of pies and sauces made from dried Abundance plums very closely resembling that of dried peaches. Among the improved varieties of native plums, the Clifford and Hunt have given good products, while the Munson and others that resemble it in becoming soft at maturity yield rather inferior dried fruit. Plums of the Wild Goose and Chickasaw groups, as well as the wild plums occurring throughout most of the southern territory, are occasionally dried for home use, but the yield of the dried product is low and the quality inferior. Very small plums or those of poor culinary quality will scarcely repay the labor expended upon them.

The treatment given plums in preparation for drying, as well as in the drying process, is the same as that outlined for peaches. The fruit is washed, cut into halves, stoned, placed in trays in a single layer, stone cavities uppermost, and given a short treatment, 20 to 25 minutes, with sulphur fumes to preserve the color. The temperatures to be employed in drying are those recommended for peaches and apricots, and the criteria for determining when the fruit is sufficiently dried are the same.

FIGS

The commercial production of dried figs in this country is confined to California, and the varieties employed for the purpose, namely, Adriatic (*White Adriatic*), Mission (*California Black*), and certain varieties of the Smyrna type, are not generally grown outside that State. Sun-drying is employed to the exclusion of all other methods in curing the California crop. Under the very different climatic conditions that prevail throughout the South Atlantic and Gulf States during the period in which figs are ripening, it is practically impossible to dry the fruit in the sun, as fermentation and spoilage almost invariably occur, and growers are strongly advised against attempting drying except with an artificially heated drier.

The following method will give good results with any of the common varieties, such as the Celeste, Brown Turkey, Magnolia, Brunswick, and Black Ischia: Allow the fruit to become well ripened on the tree, and pick over carefully after gathering, culling out all overripe, soft fruits. Dip the fully ripened but still firm fruit in

a vigorously boiling lye solution made by dissolving 1 pound of concentrated lye (caustic soda) in 10 gallons of water. The purpose of this treatment is to facilitate drying by partially removing the waxy waterproof coating of the fruit and is attained when fine parallel cracks or "checks" appear in the skin of the fruit. This result is usually secured by dipping the fruit for 1 minute, but the exact time will vary with the variety and degree of ripeness of the fruit. After being dipped in lye, the fruit must be washed in several changes of water, spread in a single, closely placed layer on the trays, and immediately placed in the drier. The temperature should be kept at 115° to 120° F. until the fruit has lost enough moisture to be noticeably shriveled, then gradually increased to 140° to 145° toward the completion of the process. The fruit should be stirred at intervals to prevent its sticking to the trays. As the fruit does not dry uniformly, it must be sorted over to prevent overdrying of the pieces that dry most rapidly. The drying has proceeded far enough when the fruit is still leathery and elastic but does not yield moisture when torn across and firmly pressed between the fingers.

BERRIES

Blackberries, Logan blackberries, and raspberries receive identical treatment in preparation for drying; hence they need not be separately discussed. Dewberries, huckleberries, blueberries, and gooseberries are occasionally dried, the method of treatment being that here outlined. Any of the cultivated blackberries, as well as the wild varieties, make excellent dried fruit. Black raspberries were at one time dried in considerable quantities but now very few of them are dried. The firmer varieties were preferred because they dried more quickly and gave somewhat greater yields than the softer varieties. Any variety can be successfully dried, however, provided care is taken not to allow the individual berries to become overripe and soft before picking. There is little commercial demand for dried red raspberries, which dry more slowly, are much more liable to crush and mat on the trays in drying, and give a lower yield of more sharply acid fruit than the black varieties; but they may be dried for home use in the same way as other berries. Logan blackberries demand particularly careful handling, as they become very soft when first heated and are especially prone to flatten out, mat together, and lose juice by dripping in the drier. They must be spread in thinner layers than other berries, and the temperature of the drier should not be allowed to exceed 130° F. at the beginning of drying, but may be gradually advanced to 145° or 150° toward the close.

Berries that are to be dried should be picked in the early morning so that they may be brought under cover before becoming heated by the sun. The vines should be picked over frequently, so that only firm, market-ripe berries are brought to the drier, and the pickers should be supplied with shallow picking vessels and instructed to avoid crushing the berries in picking and handling. Pouring the berries from one vessel to another and stacking filled boxes so that one box rests upon the fruit in another are especially to be guarded against. All berries brought in on any one day must be placed in the evaporator before the end of that day, as crushing and leakage

with the resulting multiplication of organisms causing spoilage will occur if the fruit is allowed to stand overnight. If delays in starting the drying are absolutely unavoidable, the fruit should be placed in the coolest possible place of storage until it can be accommodated in the drier. Berries that are to be dried in an evaporator should be spread uniformly on the trays to a depth varying with the ripeness and physical character of the fruit, the softer berries in a layer not more than two berries deep. If the berries are to be dried in the sun, they should be spread in a single layer. A little practice will enable one to spread berries uniformly by careful pouring from the vessels. Smoothing with the fingers and attempts to pick out leaves, bits of stem, and green berries are to be avoided, as these are readily removed after the berries are dry by passing the fruit over a screen.

The trays should be placed in the evaporator as rapidly as they are filled. An initial temperature of 135° to 145° F., gradually increased to 150° to 155° when the fruit is two thirds to three fourths dry, may be used with blackberries, raspberries, and any other berries except Logan blackberries and red raspberries, which should be started at 130°. When the berries have dried sufficiently to be stirred without crushing, the trays should be gone over and any thick clumps that are drying too slowly spread out with the fingers. The fruit is dry when it begins to rattle somewhat on the trays and when the berries no longer show moisture when crushed between the fingers.

While it is possible to dry gooseberries, currants, strawberries, and a variety of other small fruits, attempting to do so is inadvisable. Currants and gooseberries have such a wide range of usefulness that it is unnecessary to dry them in order to avoid allowing them to go to waste. The distinctive coloring and flavoring substances of strawberries are readily driven off or broken down by heating, and as the fruit is exceptionally high in water content and soft in texture, it is extremely difficult to dry without loss by dripping. The dried product is usually so effectively denatured as to have little of the appearance, color, or flavor of the fresh fruit, and is to be regarded as a curiosity rather than a valuable food material.

PREPARING AND DRYING VEGETABLES

The beginner is strongly advised to confine attempts to preserve vegetables by drying to a small number of products, for which directions are here given, and to employ canning or other means of preservation with other products. The chief reason is that many dried vegetable materials are much more prone to deterioration in flavor and table quality after drying than are dried fruits, and it is exceedingly difficult or impossible to handle the material so that these changes do not become apparent after a few months. This is especially true of those vegetables in which young, still rapidly growing parts of the plant are used, such as asparagus, spinach, celery, cauliflower, green snap beans, or green peas. When such immature vegetables are dried, the resulting product may be satisfactory in appearance, flavor, and palatability for some time, but it gradually undergoes loss of flavor and palatability and may develop a distinctly unpleasant haylike odor. These changes will quickly occur if the material is not protected from moisture, which is very rapidly

absorbed. Reduction of the moisture to a very low point and storage in hermetically sealed containers slows down but does not prevent the ultimate appearance of these changes, which are due to chemical changes in the material which we do not know how to control. Obviously it is not wise to undertake the preservation of these materials by a method that is at best temporary and hazardous, when an equal amount of labor spent in canning will yield a product that is protected against deterioration.

Potatoes, turnips, beets, carrots, and cabbage are not so prone to deterioration after being dried as the products just discussed, but at the same time they are the least rapidly perishable of the staple vegetable foodstuffs. In practically every part of the United States it is possible to store some or all of them outdoors in pits in the ground or in any ordinary cellar through the winter, thus assuring a constant supply of fresh vegetables at the expense of very little time and trouble. Whenever such pit or cellar storage is possible any labor spent in drying potatoes and other root vegetables, onions, and cabbage will be wasted. In districts that have no nearby sources of supply of staple vegetables there is usually a short period during which these products are plentiful in the markets, and wherever possible at such times supplies should be stored for winter use, either outdoors in pits roofed with boards and protected by banks of earth or in a portion of the basement or cellar partitioned off for the purpose.

Drying is not a means of utilizing vegetables that are not good enough to can or to use fresh. It cannot improve the quality of any material; it can at most merely preserve it without deterioration. In consequence, there are a number of indispensable prerequisites to the making of a high-class dried product. Material that deteriorates rapidly after gathering, such as sweet corn, must be gotten to the drying plant without delay. It is impossible to make good dried products from vegetables that have been overheated and wilted in transit or upon hucksters' stalls and have consequently begun to undergo destructive chemical changes. For first-class products the raw material must come fresh and crisp from the field, must undergo rigid examination for the removal of all diseased or overripe and decaying portions, and must be treated throughout its preparation for the drier in exact accordance with directions. Any material that would not be used for canning or readily accepted for cooking and serving on the table will not make an acceptable dried product.

Practically all vegetables, after being sliced or otherwise made ready for the drier, should undergo blanching. It is just here that the final quality of the product is largely determined, since the best material will be spoiled by careless or improper blanching. The word "blanching" is a canners' term and is applied to a brief treatment of the material with boiling water or steam. The equipment used is described on page 8. The objects of the treatment are several. It stops destructive chemical changes by destroying the agents that produce them and consequently prevents darkening or discoloration; it preserves or "sets" the natural color; it coagulates some of the soluble constituents; and it kills the protoplasm and consequently accelerates the escape of moisture in drying. Blanching must not be confused with cooking; it in no sense takes the place of the subse-

quent cooking in preparation for the table. If too long continued it does harm by dissolving out some of the valuable constituents, by breaking down the pigments that give color to the material, or by converting the starch into a partially cooked paste. For these reasons blanching, whether accomplished by dipping in hot water or by exposure to steam, must be carefully and intelligently done.

SWEET CORN

While formerly very widely practiced throughout the country, the drying of sweet corn has in recent years been practically discontinued except in a few localities in Pennsylvania and Ohio, and the product is for the greater part consumed in the immediate vicinity. That the product and the processes for making it are not widely known is unfortunate, since properly dried sweet corn is considered by many people to be fully equal if not superior to canned corn and capable of use for practically as wide a variety of purposes.

Any of the varieties of sweet corn having qualities desirable for table use will make a good product. Golden Bantam, Golden Sugar, Oregon Evergreen, Kelly Hybrid, New Early Wonder, and Black Mexican have given especially good results. Where corn is grown especially for drying, Stowell Evergreen is largely employed, because it gives heavy yields of excellent quality; it ripens, however, somewhat less uniformly than Golden Bantam and Country Gentleman, so that a large number of pickings are necessary.

Corn to be dried should be gathered when in the milk stage, before glazing and hardening have begun and when it is in ideal condition for immediate table use. It should be gathered only as rapidly as it can be worked up at the drier and must never be allowed to remain standing in bags or boxes in the field or at the drier. This is imperative, as no product deteriorates more rapidly on standing in a warm place.

The ears are husked and trimmed with a knife to remove any worm injuries; but no effort to remove adhering silks need be made, as these are readily separated from the grains after drying. The ears are then placed in wire baskets or wire-bottom boxes and plunged into boiling water for 8 to 12 minutes. The blanching is completed when the milk is "set", that is, when no fluid escapes from the grains when they are cut across. Younger corn will require a longer period of blanching than the more mature ears, so that the corn may very well be divided in husking into older and younger lots, which are treated separately.

After being blanched, the corn is emptied upon a table, allowed to drain and cool sufficiently to be handled, and then cut from the cobs with a strong, sharp knife. The knife should be so held that none of the cob is removed with the kernels. The adhering glumes, like the silks, are easily screened out after the corn becomes dry. The kernels are spread upon trays to a depth of one half to three fourths of an inch. Best results are obtained if the drying is begun at rather high temperature, 165° to 175° F., and decreased somewhat as the corn approaches dryness. Consequently the process of drying in the tunnel is reversed, the fresh corn being inserted at the lower end and progressively moved toward the upper cooler end as the drying proceeds. The grain should be thoroughly stirred several times

during the drying, to separate any adhering masses and equalize the drying. Properly dried corn is hard and semitransparent, and the kernels break with a clean, glasslike fracture when crushed.

When steam is available it may, of course, be used for blanching, but care must be taken that there is an active flow of steam through the box and that the corn is rapidly heated to boiling temperature.

PUMPKINS AND SQUASH

Pumpkins used for drying may be of any variety, but the firm, solid-fleshed, deep-colored varieties give a larger yield of a more highly flavored and consequently more desirable product. Either summer squash or the later maturing varieties may be dried. In any case the vegetables should be mature and in good condition to use fresh.

The treatment given pumpkin and squash is identical. The vegetable is cut into strips 1 to 2 inches wide and peeled; the seeds and stringy, pithy material are removed; and the strips are then cut by hand or by being passed through a rotary slicer into pieces one half to five eighths of an inch in thickness. The pieces are immediately blanched, either in boiling water or in steam, for 3 to 6 minutes. The different varieties vary so much in character of flesh and in amount and depth of coloration that the operator must necessarily learn by a little experimentation the best length of time for blanching the particular lot of material on hand. The process is completed and must be stopped as soon as the pieces have become semitransparent.

The drying should be begun with a temperature of approximately 135° F., which may be gradually increased to 160° as the material dries. The trays should be looked over once or twice, in order that any moist spots may be opened up and spread out. Pumpkin and squash should not be dried until brittle; the material is in proper condition for removal from the evaporator when the pieces have become leathery in texture but show no moisture when cut across and crushed.

CABBAGE

Cabbage is so readily stored for long periods in outdoor pits or in the cellar and is available on the markets for so large a part of the year that the labor expended in drying it would not be justified under most circumstances. Also, sauerkraut is widely popular and may be prepared and preserved with a relatively small expenditure of labor and money. For these reasons the drying of cabbage should be undertaken only in the exceptional case that is justified by circumstances.

Cabbage is prepared for drying by trimming off all dead, diseased, or discolored leaves, cutting out the central stalks, and cutting the heads into slices one third to five eighths of an inch thick, which are subdivided by again slicing at right angles to the first cut. A rotary slicer of sufficient size to receive a half head of cabbage will do the work rapidly and satisfactorily, but an ordinary slaw cutter, or even a butcher knife, may be used. The sliced cabbage is blanched by being exposed to steam for 3 minutes after it is spread on the trays or by being dipped in boiling water in a wire-bottomed box or basket for 4 minutes. The dipping vessel should not be filled to a depth of more than 6 to 8 inches, and the contents should be stirred vigorously

during the dipping in order that the hot water may quickly reach all parts of the vessel. Since cabbage tends to pack together rather closely on the trays, care should be taken to spread it as evenly as possible to a depth of not more than 1 inch, and to stir the material frequently in the earlier hours of drying in order that thick masses may be spread out over the thinner areas. Start the drying at 115° to 125° F. and increase the temperature by 10° as drying nears completion. Great care must be taken to avoid scorching the product; the thin portions of the leaves dry much more quickly than the thick, fleshy ribs and are very prone to scorch and brown upon the slightest overheating. The product is sufficiently dry when no water can be squeezed out of the thicker pieces by strong pressure between the fingers.

ONIONS

As no satisfactory machine for the purpose has been devised, the outer discolored portions of onions must be removed by hand. The remainder is then sliced with a rotary slicer, a hand apple slicer such as is shown in figure 1, or by hand. Blanching is not necessary, and the slight improvement in color that it gives is more than offset by the loss of soluble constituents in the water used for dipping. The onions should be spread on trays as rapidly as they are sliced and immediately placed in the evaporator. The temperature in the drier should be 140° F. when the onions are placed in it and should be held at this point throughout the drying. The product must be carefully watched toward the end of the process, as thin detached pieces rapidly scorch unless mixed with the thicker, compact slices. The product is dry when pieces break crisply when bent, and it should be promptly removed to guard against overdrying.

The evaporator may also be used for curing onions to prevent storage rots and to prolong their season of storage. Alternate trays of the drier are used and the onions are loosely piled on them to a depth of 4 to 6 inches. The ventilators are all opened, and a very small fire, just sufficient to maintain a temperature of 95° to 100° F., is started in the furnace. The drying is continued until the outer scales are quite firm and hard and the onions have lost 8 to 10 percent of their weight, after which they are stored in the usual manner.

SWEETPOTATOES

Under ordinary circumstances it is inadvisable to dry sweetpotatoes, as they can be kept in the fresh condition through the winter if proper storage conditions are provided; consequently the conditions in any particular case must determine whether drying is worth the labor involved.

The evaporator may be of service in preserving sweetpotatoes in two ways—by drying them ready for use, or by curing or partially drying them to increase the time during which they may be kept in storage in the fresh condition.

Sweetpotatoes that are to be dried should be thoroughly washed and carefully inspected for the presence of decay. If they are fairly smooth and regular in shape they may be peeled by the use of a peeler such as is shown in figure 3. If they are very irregular in shape, peeling by machine will be irregular and wasteful, and peeling should be accomplished by means of a short immersion in boil-

ing lye. A $1\frac{1}{2}$ to 2 percent solution is used and must be kept actually boiling. Varieties differ considerably in the time required to loosen the peel, but 2 minutes is usually sufficient. After being thoroughly washed under the tap the peels are slipped off by hand and the sweetpotatoes again inspected for decay. They may be cut into slices like potatoes or carrots, or split lengthwise into quarters or eighths according to size, and dried in that form. If sliced, 20 or 25 minutes in steam is sufficient for cooking; if cut into quarters, the time should be increased to 30 minutes, as the sweetpotatoes must be thoroughly cooked. The temperature of the drier may be 145° to 150° F. at the beginning of the drying and may be raised 10° or 15° after the product loses most of its moisture. Sweetpotatoes should remain in the drier until the pieces have become quite brittle and break readily under pressure.

In humid districts in which the storage period for sweetpotatoes is comparatively short, an evaporator may be used advantageously for partially drying or curing them to increase their keeping period. The sweetpotatoes are brought from the field or market, spread on the trays one or two deep, and placed in the drier, which is kept at a temperature of 90° to 100° F. by slow, careful firing with all ventilators open. After 48 to 72 hours of this treatment they will have lost 5 to 10 percent of their weight and will have become slightly shriveled superficially. All cuts or broken surfaces will have dried out. The sweetpotatoes are then removed and stored in bins or cellars in the usual way. The ordinary fungi that cause rotting in storage do not readily attack sweetpotatoes that have been subjected to this treatment, and the cooking qualities and flavor are entirely unaffected by it.

BEANS AND PEAS

If facilities for canning under steam pressure are available or can be procured, green snap beans and green peas should be canned rather than dried. It has already been pointed out that immature beans and peas deteriorate rather readily in storage when dried. There are also great differences in the quality of the product from the different varieties when prepared and dried in the same way. Some of the widely grown varieties of runner or pole beans make very acceptable dried products if harvested and dried when the seeds have reached two thirds to three fourths their full size. In some sections of the country it is a common practice to interplant such varieties of beans with corn, which serves to support the vines and to pick and dry the immature pods. Some varieties of bush beans also make very satisfactory dried products. Others make mediocre or poor products, tough and woody in texture and deficient in flavor, regardless of the methods used in preserving and drying them. The numerous varieties of beans have not been studied in sufficient detail with reference to their quality when dried to make it possible to class them as desirable or undesirable for drying; consequently, unless it is definitely known that the variety being grown is one that makes a desirable product when dried in the immature stage, it is recommended that the beans be canned. If this is impossible, allow them to become full-grown, when they will have increased very greatly in food value, before drying them.

Wax beans, lima beans, or mature string beans for drying should be gathered when full-grown but before the pods have begun to dry, shelled, blanched 3 minutes in boiling water with thorough agitation, dried, and spread on trays to a depth of not more than 1 inch. They should be stirred rather frequently in the first hours of drying. Considerable variation in the temperature employed is permissible, but the material should not be heated above 150° F. at the outset.

Garden peas intended for drying should be gathered when in ideal condition for immediate table use—that is, when the seeds have attained full size and before the pods have begun to turn yellow and dry up. Shell them by placing the pods in boiling water for 3 minutes, then spread on a wire screen having a mesh large enough to permit the shelled peas to pass through, with a box or basket placed beneath it. Rub the pods vigorously over the screen with the hands; this action will burst and empty practically all the pods much more quickly than they could be shelled by hand. The shelled peas are then given a very short dip, 1 or 2 minutes, in boiling water to which table salt has been added at the rate of 2 tablespoonfuls to the gallon; they are then drained, spread to a depth of three fourths to 1 inch on the trays, and dried at 115° to 120° F. as initial temperature, rising to 140° toward the completion of the drying. Stir occasionally while drying. Properly dried peas will be uniformly dry throughout, showing no moisture near the center when split open.

Beans and peas that have been allowed to dry on the vines may advantageously be given a short treatment in the drier before being stored. Shell, spread to a depth of one half to three fourths of an inch in trays, and place in the drier for 10 to 15 minutes at 165° to 180° F. This treatment will destroy insect eggs and bean weevils, thus reducing the possibilities of loss in storage; but it also destroys the vitality of the material treated, which consequently cannot be used for seed.

CELERY

To make an acceptable dried product, celery must be such as would be accepted without question for use fresh. Consequently, it must reach the drier without having been allowed to become heated and wilted in the crates. All diseased and discolored parts are removed, the leaves are stripped off, and the stalks cut by means of a rotary slicer into pieces about three fourths of an inch long. These pieces are steamed 3 minutes, or given a 2-minute dip in boiling water, spread about one half inch deep on trays, and dried at 135° F., with occasional stirring. If desired, celery leaves may be dried separately from the stalks, for use in flavoring soups and stews. They may be passed through the rotary slicer or dried entire. Blanch them 2 minutes, spread them thinly, and stir frequently, employing a temperature of 125° to 140° F. If intended for use in soup mixtures, stalks and leaves may be cut rather finely and dried together.

TREATMENT OF PRODUCTS AFTER DRYING

The beginner in drying is prone to think that the careful and exacting part of his task is over when his material has passed through the evaporator and that dried products need no particularly

close attention. Such is by no means the case. Dried materials are nonperishable only if they are adequately protected against absorption of moisture and attack of insects; if they are not given such protection deterioration and spoilage very quickly occur. Consequently, if the materials are to be protected against loss, close adherence to the instructions for curing and storing in the following paragraphs is not optional but imperative.

CURING OR CONDITIONING

Material as it comes from the evaporator is never uniformly dry; even in a single tray some pieces will have too much moisture for safety, while others will be somewhat overdried. If such material is immediately stored, deterioration and spoilage are likely to occur as a result of the growth and multiplication of organisms in the wetter portions. The curing or conditioning treatment prevents this. In reality it is a continuation at a slower rate of the drying process. The curing room should be a warm, dry room, screened to exclude insects, with blinds or shutters to exclude direct sunlight, and provided with bins or large boxes to contain the dried materials. The warm fruit is poured directly from the trays into a bin or upon the floor, and the product of several successive days' work is added to the pile, which is thoroughly stirred at the time of each addition, to mix the freshly added warm fruit with that already present. The mass is thoroughly stirred daily for 2 or 3 weeks, the room being kept warm in the meantime. As a result of this treatment the wetter portions give up some of their water to the drier portions or to the atmosphere, the moisture content of the entire mass becomes uniform, and a condition of equilibrium with the surrounding air, such that the material neither absorbs nor gives off measurable quantities of moisture, is presently attained. The operator will be able to judge when this condition has been reached by testing the "feel" of a handful of the pieces. In the case of fruits, material properly conditioned should yield no moisture when a handful is strongly compressed, but should be spongy and yielding, like a handful of rubber bands, and should fall apart again when the pressure is released. Fruit will show this condition when the moisture content ranges between 20 and 24 percent. The last-named figure is the legal moisture content for evaporated apples and represents a limit that cannot be materially exceeded without danger of spoilage. If the fruit feels wet to the touch or sticks together when compressed, the moisture content is too high for safety, and the fruit should be piled fairly deeply on trays and returned to the drier for a few hours. In any doubtful case it is well to remember that while underdrying may result in a loss of material, overdrying is perfectly safe. No harm is done by drying fruits until the pieces are hard and hornlike, provided excessive temperatures have not been used.

In the case of vegetables, drying should be continued until the material is hard and inelastic, and the conditioning process should not result in loss of crispness and brittleness. The moisture content when the material is stored should not be more than 8 or 10 percent, and it may be reduced somewhat below this figure with advantage. There are very good reasons for making this difference in moisture content between evaporated vegetables and fruits. In fruits, spoil-

age is due to the activities of yeasts and molds that attack the sugars present, and these organisms are unable to grow or multiply when the moisture content of the material is below 24 percent. Most vegetables contain considerable amounts of protein, and spoilage is usually due to the activities of bacteria and molds that attack proteins. Some of these organisms are able to continue their activities upon proteins when the moisture present is very little above 10 percent; also, slow destructive changes in proteins, not due to organisms but occurring spontaneously, may occur in protein-containing material with a moisture content above 10 percent. Consequently vegetable material should still be brittle and inelastic when the curing process is completed.

If the curing room or the storage bins have been properly protected against the entry of insects, material may be packed for storage as curing is completed. If there are any indications of insect infestation, or if there is any question as to the adequacy of the protection against insects during conditioning, the material should be piled loosely on trays, returned to the drier, and heated to 165° to 180° F. for 10 to 15 minutes immediately before packing.²

PACKING

Fruits are packed commercially in wooden boxes lined with several layers of paraffined or waxed paper so placed that the edges overlap. The fruit is packed in under pressure from a powerful press so that it forms a compact, rather tightly compressed block. While the waxed-paper wrappings are not airtight, the compression of the mass prevents the penetration of air into the interior, so that changes in moisture content are confined to the surface of the block. Since the protection given by the wrappings is largely destroyed once the package is opened and part of the contents removed, the 10-, 25-, and 50-pound boxes are not well adapted to home use because of the deterioration that is likely to occur before all the material is used. For storage of home supplies, smaller containers that are nearly or quite airtight and readily resealed after opening are desirable for fruits and a necessity for vegetables. Tin cans with closely fitting slip covers—lard cans—are available in various sizes, and tin cans with friction tops of the types in which sirups, coffee, cottonseed cooking oils, and other food products are sold are equally good. Glass jars are satisfactory insofar as protection against insects and moisture are concerned but are bulky, expensive, breakable, and have the disadvantage that they do not exclude light. Paper cartons made of heavy paper infiltrated with paraffin and provided with closely fitting slip-top covers are also satisfactory. Paper containers that are not moisture proofed are to be avoided, as moisture absorption occurs, and infestation by insects that bore through the paper may also occur. For these reasons attempts to store dried products in cloth or paper bags without some additional protection against access of moisture and insects are likely to result in spoilage and loss of material.

² Various fumigating agents are used in commercial plants for controlling insects. All of these have some characters that render their use by inexperienced persons and under ordinary home conditions inadvisable. Hydrocyanic acid gas is an intensely poisonous gas; carbon disulphide is inflammable and explosive; and carbon tetrachloride, although safe, is much less reliable. Heat treatment is not ideal but is the safest method available at present for general home use.

STORAGE

The room in which dried fruits and vegetables are to be stored must be warm and dry. The ordinary pantry or storeroom communicating with the kitchen is not well suited to the purpose, since the constant evaporation of water from vessels on the stove keeps the air quite humid, and evaporated materials consequently take up moisture and ultimately spoil. An airy attic that is kept warm by flues or pipes passing through it from the living rooms below makes an ideal storage place; containers of dried products may be placed near the pipes so that they are kept slightly warm. If the house has a furnace, open shelves may be constructed near it in order that the material may be kept dry and warm by the heat of the furnace.

In districts having exceptionally long periods of high humidity and almost constant rainfall at certain seasons, special care will be necessary in order to avoid spoilage of dried material. At such seasons the packages of dried fruits and vegetables should be opened and examined, and any that appear to be taking on moisture should be returned to the drier or to the oven of the cookstove and given a sufficient heating to restore them to their original condition. One such treatment in the course of the rainy season is usually sufficient to prevent any loss, but the material should be examined from time to time and given a second treatment in case any portions of it appear to be too moist for safety.